Risk Assessment

Emergency Regulatory Activities for Medfly

Planning and Risk Analysis Systems
Policy and Program Development
Animal and Plant Health Inspection Service
U.S. Department of Agriculture

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Executive Summary

This risk assessment was conducted to determine the risk level of each activity Plant Protection and Quarantine regulates in an eradication program for Medfly or Mediterranean fruit fly, *Ceratitis capitata*, managed under "bull's-eye" or "areawide" concepts. The risk of these activities leading to new outbreaks outside the quarantine area was assessed. These risk values help managers assign their resources in a more cost-effective and timely manner.

The six steps of scenario analysis were applied: (1) determine the assessment objective, (2) identify the hazards, (3) develop a scenario tree of the parameters leading to a new outbreak, (4) gather evidence, (5) develop each parameter estimate, and (6) calculate outbreak probabilities and summarize results.

An expert group with expertise in fruit fly biology, control, and eradication regulatory activities identified the hazardous activities. These activities fell into nine groups of establishments: nurseries, orchards, nonresidential landscape fruit trees, residential hosts, retail and wholesale fruit handlers, small-lot commercial conveyances, waste disposal sites, and yard maintenance.

After participants reviewed the evidence, they estimated the likelihood of Medfly occurrence for a scenario parameter, and developed estimates for adjacent areas or similar activities relative to the original estimate. Thus, relative values were derived, allowing each value to be compared to others.

The relative risks are summarized for regulatory activities in California under a bull's-eye program in the Los Angeles and the Santa Clara areas and under an areawide program in the Los Angeles area. For both programs, the highest-risk establishments are certain commercial orchards, high-risk haulers, research plots, small-lot commercial conveyances, harvesters, processors, and nonresidential landscape fruit trees, plus wholesale nurseries under bull's-eye programs. Risk from retail fruit handlers is significant for certain yard sales and mobile vendors; other retail fruit handlers such as supermarkets, small groceries, fruit stands, and pushcart vendors pose little risk. The moderate risk under both programs presented by residents in the core who grow good hosts becomes significant when the very high number of residents is considered.

Determining the risk of each regulatory activity relative to the risks of other activities is important for prioritizing work levels, control, and eradication tasks. Results allow risk managers to develop regulatory guidelines to limit potential risks of more Medfly outbreaks occurring during an eradication. Further, results could be modified to assess regulatory activities for a Medfly eradication program in Florida or Texas. Also, the methodology can be developed to assess regulatory activities for other fruit fly species.

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Introduction

Objective

A fruit fly eradication program can cost millions of dollars in resources. If the risk level of each regulated activity were known, managers could assign their resources in a more cost-effective manner. This study proposes to determine these risk levels.

The objective was to determine the risk level presented by each activity Plant Protection and Quarantine (PPQ) regulates in a Mediterranean fruit fly, *Ceratitis capitata*, eradication program in California. This limited scope allowed the assessment to be completed in a relatively short time. This assessment could be used for a Medfly program in Florida or Texas. Some modification or adjustments may be desirable because of differences in host availability and possible cultural differences in the use of fruit by human populations in these two States. This assessment cannot be used for other fruit fly species, although the methodology could be used to develop other assessments.

The assessment considered and measured the risk from the various activities for an eradication program conducted under the traditional "bull's-eye" concept used in the United States (generally a 9- by 9-mi square with the original fly captured in the center) and the "areawide" concept currently being conducted in Los Angeles, California.

Results of this assessment will allow risk managers within PPQ to develop regulatory guidelines to limit the risk of additional outbreaks occurring during a Medfly eradication program.

Methodology–Expert Group

A major component of this assessment methodology was the use of an expert group. Most of their participation occurred during a 4-day meeting at the current Medfly project in California in July 1994. Several participants did aid in the development of the assessment before this meeting. The participants are listed on page 1 of this document. The participants included persons with expertise in fruit fly biology and control, in regulatory activities associated with fruit fly eradication projects, or in both. About one-half of the experts attended all 4 days. The others participated as needed and as their availability allowed. The experts helped in the hazard identification process (mostly completed before the meeting) and in the development of various estimates for the parameters needed to determine the risk. These estimates were derived by what Stan Kaplan (1991) calls the informative approach. Quantitative and qualitative information (evidence) relevant to the parameters was reviewed and discussed by the participants. After the discussions, estimates were established for each parameter. The experts were responsible for presenting, discussing,

and if possible, agreeing on the meaning of the evidence. The experts were asked, not their opinion of the risk, what facts they knew pertaining to the various parameters and to help develop estimates for those parameters.

Scenario Analysis Approach

This analysis involves six steps.

1. "State the question" of the assessment objective. As given earlier, it is to determine the level of risk presented by each activity that PPQ regulates in a Medfly eradication program.

2. Identify the hazards. For this assessment it was to list all establishments and activities regulated during an eradication program.

3. Develop a scenario or event tree that identifies those parameters that must occur to pose a threat of a new outbreak.

4. Gather the evidence available for each parameter (See Appendices E1 through E11).

5. The expert group then develops estimates for each parameter.

6. Calculate the probabilities of outbreaks occurring for each of the activities and then summarize results.

Point Estimate of Relative Risk

This assessment is quantitative, using relative, not finite, estimates for each parameter and for the final risk for each of the regulated activities. Probability is estimated on a scale generally from 0 to 1, with the highest value assigned to the highest chance of occurrence. For example, the parameter P_1, which represents the probability of adult flies occurring in an area, is highest in the core of a quarantine area, so a value of 1.0 is assigned to core areas. After assessing the available evidence, we then estimate that areas adjacent to the core are 20 times less likely to have adult flies than do areas within the core. Therefore, a relative value of 0.05 is given to areas located next to the core within the first buffer. By this method and the scenario analysis approach described above, relative risk values were developed for the possible scenarios, allowing each risk value to be compared to each other. The risk of yard oranges located within the core of the quarantine, leaving the quarantine area and causing an infestation can be quantitatively compared to an avocado packinghouse located 3 mi from fly finds.

The risk manager must consider the different units assessed and their frequencies to compare one regulated activity to another. The unit for nursery, retail fruit handler, and residential host groups is the amount of host material sold or given away to one person in one day. For the orchard group and for nonresidential landscape fruit trees, the unit is the amount harvested from one property at one time (generally in one day but may last over a few days). For the wholesale fruit handler, small-lot commercial conveyance, waste disposal

site, and yard maintenance group, the unit is the amount of fruit contained at handled by, or passed through the facility in one day.

The estimates developed for each parameter are point estimates and are judged to be the most likely value; therefore, they represent the mathematical mode. The relative risk of the probability of a new outbreak for each scenario (represented by the parameter P_s) is multiplied by 10,000 to create an index scale where most values are 1 or higher with few values less than 1.

Uncertainty

Uncertainties considered in this assessment included random errors (sampling error) where there are statistical methods for quantifying, and other errors or variables that cannot be measured statistically. These unquantifiable errors include errors in measurement and modeling. In general, uncertainties in this assessment are described qualitatively (e.g., reasonably certain, moderately certain, etc.). If the degree of uncertainty concerning a specific parameter were the same for all regulated activities, then uncertainty is discussed in the assessment section for that parameter; otherwise, uncertainty is discussed or at least rated in the assessment section for each activity.

Definitions

The following definitions are given to enhance the understanding of this assessment.

Risk—the likelihood and magnitude (the consequences) of an adverse event occurring, a measure of the probability of harm and severity of the adverse effects.

Risk analysis—the process that includes risk assessment, risk management, and risk communication.

Risk assessment—a process of identifying hazards, estimating the probability for each adverse event to occur, and estimating the magnitude of the consequences.

- Hazard—element or event that is potentially harmful, an adverse event or outcome.

- Hazard identification—describing what might go wrong and how this might happen.

Risk management—process of identifying, evaluating, and recommending alternatives for mitigating risk.

Risk communication—open exchange of information and opinion leading to a better understanding of risk and risk-related decisions.

The Assessment

State the Question

Determine the level of outbreak risk presented by each activity that PPQ regulates in a Medfly eradication program.

Hazard Identification

Before the expert meetings, various establishments and activities that pose a threat were identified and listed from both historic and currently used operational program documents. This list was modified during the meeting by the regulatory experts. Activities similar to each other were grouped to aid the assessment process.

Hazardous Activity Groups

Nursery Group
General Retail Nurseries
Exotic Retail Nurseries
General Retail Stores
selling nursery stock
Wholesale Nurseries

Orchard Group
Abandoned Orchards
Research Plantings
Commercial Orchards (Large)
Commercial Orchards (Small)

Nonresidential Landscape Fruit Trees

Residential Hosts

Retail Fruit Handler Group
Supermarkets
Convenience Stores
Small Groceries
Farmer's Market or Fruit Stands
including flea markets
Yard Sales
Mobile Vendors
Pushcart Vendors

Wholesale Fruit Handlers Group
Packinghouses
Distributors
Foodbanks
Haulers
Processors
Receivers
Harvesters

Small-Lot Commercial Conveyances

Waste Disposal Sites
Landfills
Green Waste Recyclers

Yard Maintenance

Scenario Tree

The basic risk model (fig. 1) uses the following symbols.

s = a scenario describes a chain of events that could reasonably occur within the quarantine area that poses a risk to establishing a new outbreak outside the quarantine area.

E = Evidence or information about the risk. It is generally summarized in the evidence section and was used to help identify the hazards and estimate the probabilities of the various small-lot commercial conveyances parameters occurring for each scenario.

P_1 = Probability (relative) of flies being in the general area of a regulated activity.

P_2 = Probability of host fruit being exposed to Medfly ovipositioning.

P_3 = Probability of the host fruit species attracting the fly for ovipositioning and of the fruit providing suitable nutrition to the larvae to mature as fertile adults (host preference).

P_4 = Probability of this infested fruit leaving the quarantine area.

P_5 = Probability of the young Medfly resulting from the infested fruit lot that left the quarantine area, surviving, mating, and finding host fruit.

P_s = Probability of a new outbreak occurring from a fruit lot associated with a given scenario.

The basic risk model is described by

$$P_1 \times P_2 \times P_3 \times P_4 \times P_5 = P_s$$

Graphically, the model is represented by the following scenario tree.

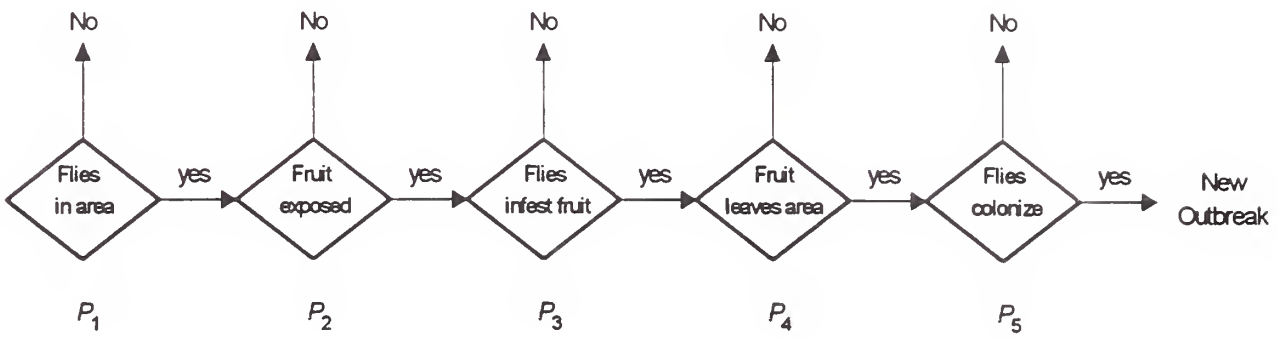

Figure 1. Scenario tree: risk of a new outbreak

Parameter Discussion

See parameter evidence in appendices E1 to E11.

Parameter P_1

The first parameter is concerned with the relative density of flies in different locations within a typical outbreak, or the relative probability of flies being in a given property type in different locations under an outbreak. For example, P_1 may compare the probability of flies being in a yard or near a fruit vendor in the core relative to the probability of flies being in or near regulated activities in the outer buffer of a quarantine area. We estimated the values for this parameter by reviewing data from 10 recent Medfly outbreaks (see E1) in California and Florida. These values were then set up for the regulated activities conducted under bull's-eye and areawide programs.

Bull's-eye Program—After detection traps capture one or more Medfly adults, additional traps are placed to determine if an outbreak has occurred and/or to delimit the outbreak. Generally, the additional trapping occurs in an 81-mi^2 area around the fly find. The area is divided into a core area (1 mi^2 for a single fly capture) and several buffer areas. Fig. 2 illustrates this grid. This configuration is called a "bull's-eye" grid, concept, or regulated area. More traps per square mile are placed in the core area and in the 1st buffer than in buffer areas farther out. The size of the core area enlarges if several flies are captured in different traps during the first detection or if additional flies are captured at a significant distance from the original capture. The core is generally a rectangle with its borders 0.5 mi or more around all fly captures.

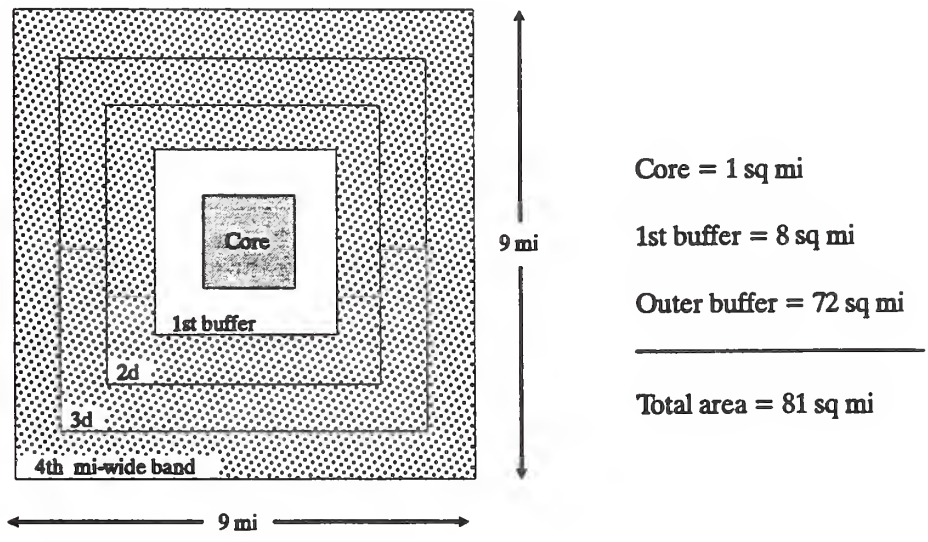

Figure 2. Bull's-eye grid, diagrammatic

For this assessment and its risk management, the probability of fly presence is assessed for three zones: the core, the first buffer, and the outer buffer made up of the 2d to 4th mi-wide bands. Because the same areas are used for quarantine purposes in most Medfly outbreaks, this breakdown will be useful.

Areawide Program—The current eradication project in California has combined several bull's-eye outbreak areas into one area under an "areawide" concept (fig. 3). The assessment did not use capture data obtained during the current program because when cores were near each other, we could not pinpoint which flies were captured from which core. The areawide program divides the quarantine area into an interior area and a perimeter area. The interior contains all core and 1st buffer areas; all other interior areas are considered outer buffer areas for this assessment.

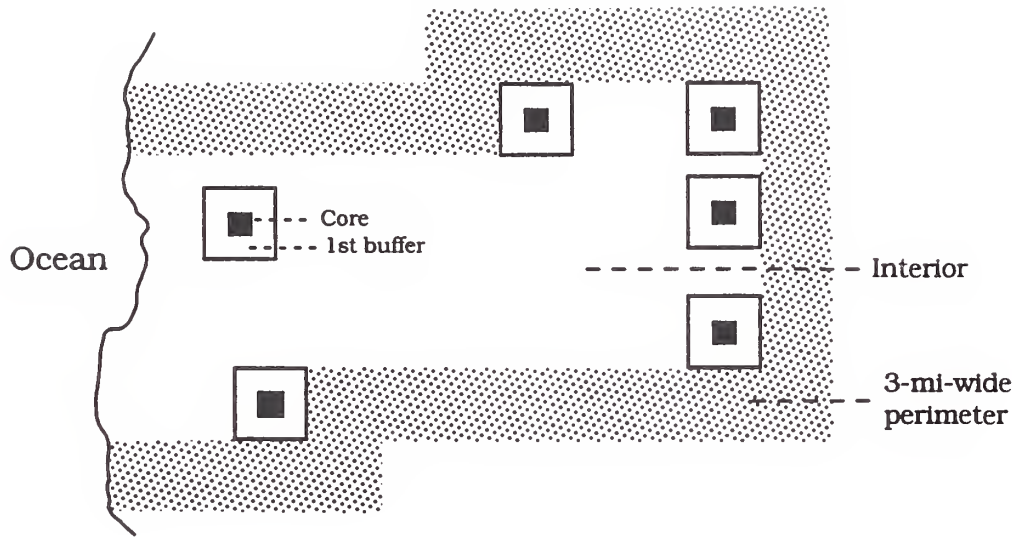

Figure 3. Areawide grid, diagrammatic

During delimiting surveys, either program may use traps baited with trimedlure, a male attractant (panel and Jackson traps), and with food (McPhail traps). Because trimedlure is a generally more effective attractant than food bait, results from these traps have been separated from other trap results (table 1).

Discussion of table 1 revealed a study by Lance and Gates (1994). They showed that about 50 percent of released Medfly males are recaptured when released within areas trapped at 1,000 traps/mi^2 density. This discussion led to the development of table 2, where data is recombined by trap density. Note that captures per trap within the core area was 0.0446 per trap for 1000-trap densities compared to 0.1567 for the 100-trap densities. Flies per trap for the 1st buffer and outer buffer showed no significant difference. The assessor

Table 1. Calculating relative fly density using fly capture/traps from prior outbreaks

Outbreaks	Trimedlure Traps						Trimedlure and Food Bait Traps					
	Core		1st Buffer		Outer Buffer		Core		1st Buffer		Outer Buffer	
	No. flies	No. traps	No. flies	No. traps	No. flies	No. traps	No. flies	No. traps	No. flies	No. traps	No. flies	No. traps
California:												
Los Angeles, 1987	22	100	7	400	1	1200	30	125	8	440	4	1560
West L.A., 1988	29	100	5	400	4	1200	38	150	5	440	4	1560
Northridge, LA, 1988	2	100	0	400	0	1200	24	125	0	440	2	1560
Mountain View, 1989	21	100	0	400	0	1200	24	125	0	440	0	1560
Country Club Park, 1991	19	1100	2	400	0	1320	21	1200	2	480	0	2040
Oceanside, 1992	1	1000	0	400	0	1320	1	1110	0	440	0	1680
San Jose, 1992	119	1050	0	400	0	1200	122	1075	0	440	0	1560
Granada Hills, 1993	46	1000	9	400	7	2160	46	1025	9	440	8	2520
Florida:												
Miami, 1984	6	100	1	400	7	1200	6	113	1	508	0	1200
Miami Springs, 1990	14	100	6	400	0	1200	16	105	6	440	0	1560
Total	279	4750	30	4000	19	13200	328	5153	31	4508	18	16,800
Flies/trap	0.0587		0.0075		0.00144		0.0637		0.00688		0.00107	
Flies/trap relative to core	1.0		0.128		0.0245		1.0		0.108		0.0168	

assumes from the above that at very high density trappings (1,000 traps/mi^2) the traps compete with each other for the capture of a limited number of flies. At lower trap densities, however, increased trapping proportionally increases the number of flies captured. For example, doubling traps from 10 to 20 per square mile would presumably double total fly capture, but captures per trap would remain the same. Because of this, the following relative fly densities for P_1 is estimated from the relative capture rates in programs using 100 traps per core (table 2).

Core area	1.0
1st buffer	0.05
Outer buffer	0.01

The above relative densities would then indicate that Medfly for a given property type would be 20 times more likely to occur within the core than within the 1st buffer. However, the core is generally a 1-mi^2 area compared to the 8-mi^2 area of the 1st buffer; therefore, the number (frequency) of yards in the 1st buffer would be eight times greater.

Parameter P_2

This parameter is concerned with the fruit being exposed or located in a desirable microhabitat for the fruit fly. Shaded, ripe yard fruit is accessible to Medfly; fruit located in open, sunny areas or within retail stores is not accessible or is much less so. Two factors affecting P_2 are considered.

Table 2. Comparing capture rates with trap density from trimedlure-baited traps

Outbreaks	Core		1st buffer		Outer Buffer	
	No. Flies	No. traps	No. Flies	No. traps	No. flies	No. traps
Six outbreaks with 100 traps/core	94	600	19	2400	12	7200
Flies/trap	0.1567		0.0079		0.00167	
Relative captures to core	1.0		0.05		0.010657	
Four outbreaks with 1000-1100 traps/core	185	4150	11	1600	7	6000
Flies/trap	0.0446		0.0069		0.00117	
Relative captures to core	1.0		0.1547		0.0262	
All 10 outbreaks	279	4750	30	4000	19	13200
Flies/trap	0.0587		0.0075		0.00144	
Relative captures to core	1.0		0.128		0.0245	

The factors affecting P_2 include:

- One is the physical separation of the fly from the fruit. This separation includes such things as doors, screens, negative air flow, packaging, and the distance of the fruit from a favorable fly microhabitat.

- The second concern is to what degree is the fruit location a favorable microhabitat for oviposition? Is the fruit in the shade? What is the microhabitat temperature around the fruit? Fly activities stop if temperatures are too high or too low. Threshold temperatures for Medfly activity range between 15 °C and 33 °C with optimal temperatures between 22.2 °C to 30.8 °C (Miller, et. al. 1992).

Fruit ripening on a yard tree was given the highest P_2 value of 1.0. Fruit in other situations was given a relative value (the same or less) to reflect the probability of fruit exposure to flies ovipositing in that situation, given that the fruit is the same and that the flies occur in both general areas. These relative values and the evidence are given for each activity in the next section of the assessment.

Because of the large amount of variability concerning parameter P_2 for individual establishments within each activity, and also because of the subjectiveness of the estimate, the uncertainty of these estimates is fairly large.

Parameter P_3

This parameter is concerned with the relative likelihood of different species of fruit being used for oviposition and producing adults (host preference). The expert group rated the various hosts listed in the Federal domestic quarantine during a California outbreak (E2), hosts found infested with Medfly during U.S. mainland outbreaks (E3 to E6), and certain fruits commonly encountered during eradication programs in California (E7).

The expert group used evidence E2 through E11 and two publications by Liquido, et al. (1990, 1991) to group the fruit into three host groups: good, fair, and poor (table 3). Some fruits listed as poor hosts may not be hosts under normal field conditions. The evidence given the most consideration was E3 to E4) concerning California larval finds and the studies by Liquido, et al. We assumed that the absence of larval finds in apricot in outbreaks in southern California was a function of the time of year that fruit was cut. The most productive fruit cutting for larvae took place in and around properties of multiple adult captures, but these fly captures normally occurred after the apricot season in southern California.

A P_3 value of 1.0 was given to a good host. Based on the available evidence mentioned above, the expert group estimated the following relative probability of a given fruit lot being used by Medfly:

Good host	1.0
Fair host	0.1
Poor host	0.001

Although the estimates developed for this parameter are based on a large amount of evidence, the estimates are still subjective, and thus, only moderately certain.

Parameter P_4

P_4 is concerned with the probability of a certain lot of infested fruit leaving the quarantine area. Unlike the other parameters, this one is given a finite, not a relative, estimate. If a certain fruit lot is estimated as having a 10 percent chance of leaving the quarantine area, then P_4 is set at 0.1. These estimates are given for each of the identified regulatory activities in the next section.

Evidence for P_4 is limited. The summary of an information survey of the residents in the 1992 San Jose outbreak (California Department of Agriculture 1992) contributed to the evidence along with the experience of the regulatory experts in the group from current and past outbreaks.

The judgmental and subjective nature of the estimates used for this parameter indicates a large amount of uncertainty.

Parameter P_5

This parameter is an estimate of the relative probabilities of different lots of infested fruit causing an outbreak after the lots leave the quarantine area. The most important factor concerning these estimates will be the number of live larvae per lot: the more larvae per lot, the greater the chance of at least one male and one female surviving, mating, and finding a satisfactory host.

Before the expert meeting, the assessors believed that this estimate should be based on the normal size of a fruit lot (number of kg) for each regulatory activity and the number of live larvae/kg likely to infest one lot of a certain fruit species, based on historical data from Latin America and Hawaii (E9 to

Table 3. Medfly host preference of fruits commonly grown or marketed in California

Good	Fair	Poor
Apricot	Apple	Avocado
Calamondin	Catalina cherry	California-laurel
Fig	Citrus as specified:	Cherry (sour, sweet, ornamental cherry)
Guava, *Psidium* spp.	citron	Lemon
Kumquat	grapefruit	Rangpur lime
Loquat	Meyer lemon	
Nectarine, peach	sweet lime	
Persimmon	King orange	
Plum, prune, Japanese plum	Sour orange	
White sapote	tangelo orange	
	tangerine (Mandarin orange)	
	Grape	
	Kaffir-plum	
	Mango	
	Mimusops	
	Mountain apple	
	Murraya paniculata, mock orange	
	Myrobalan	
	Olive	
	Opuntia spp.	
	Papaya	
	Pear	
	Pineapple guava	
	Quince	
	Rose apple	
	Spanish cherry	
	Surinam cherry	
	Sweet pepper	
	Walnut	

E10). In Hawaii and other areas with heavy Medfly populations, certain hosts are heavily infested compared to others (e.g., 200 larvae/kg compared to 3 larvae/kg). But because fairly low numbers of larvae infest fruit in a California outbreak, no matter what the fruit species, the expert group decided to use only lot size for estimating the value of P_5.

With a large amount of uncertainty because of the lack of hard evidence, the expert group gave typical fruit lots the following relative values:

- Large personal lot (± 4 kg), typical weight of yard fruit given to a friend. P_5 is given as 1.0.

- Small personal lot (± 2 kg), typical weight bought at a retail store. The relative likelihood was estimated as 0.5.

Estimates for P_5 are based on the above typical lots for each activity in the next section.

Assessment of Activities

Assessment of the activities at risk are presented in the order listed under Hazardous Activity Groups on page 5. Parameter estimates (step 5) and outbreak occurrence probabilities (step 6) for each activity have been placed adjacent to each other for ease of presentation. For each activity, the assumptions the expert group made to derive the probability estimates for the parameters are first discussed. Then the estimates themselves and the results of the risk calculations follow in a table or are narrated in the discussion.

Nursery Group

Nursery group includes general retail nurseries, exotic retail nurseries, general retail stores selling nursery stock, and wholesale nurseries. Trees are commonly sold bearing fruit in California. Risk arises from moving plants out of the quarantine area. The major risk is from fruiting trees. Fruit and soil can contain larvae or pupae. Nonhost or uninfested plants next to infested plants may also pose a risk by harboring pupae in planting media.

General Retail Nurseries

Sell fruiting apple, citrus, peach, guava, natal plum, fig, and avocado trees.

- P_1: The relative probability of adult flies being in the area was estimated previously. General retail nurseries are found in each of the program areas.
- P_2: The expert group estimated that the degree of fruit exposure would be one-half of the relative risk of yard fruit, thus 0.5. This estimate is based on the generally small size of the nursery stock, the limited amount of shade produced by the leaves, and the open, sunny sites of these nurseries.
- P_3: These nurseries all sell some good hosts, so infested fruit is highly likely.
- P_4: The probability of a given fruit tree with fruit leaving the quarantine area depends on the distance of the nursery from the quarantine border. We assumed that all or most of the nursery stock is sold and planted at a new location, generally someone's yard. We also assumed that most people shopped at general retail nurseries within a few miles of their homes.
- P_5: Based on a homeowner buying one or two fruit trees that bear a relatively small amount of fruit (± 2 kg), the relative probability of colonization was estimated as 50 percent of a yard fruit lot.

See risk estimates and calculations in table 4. Note: Because P_1 can have three values and P_4 can have three values, this activity has seven scenarios.

Exotic Retail Nurseries

This retail nursery sells specialty nursery stock (e.g., Asian fruit trees). The expert group assumes that people will drive long distances (± 20 mi) to buy these products because few nurseries carry these specialty products.

Parameter values for an exotic retail nursery would be the same as for general retail nursery, except for P_4. See risk estimates and calculations in table 5.

Table 4. General Retail Nursery Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0			Bull's-eye = 0.5	
1st buffer = 0.05	0.5	1.0	Areawide • Interior = 0.05 • Perimeter = 0.5	0.5
Outer buffer = 0.01				

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Relative Risk Index
Bull's-eye	Core	1250
	1st buffer	62.5
	Outer buffer	12.5
Areawide		
Interior	Core	125
	1st buffer	6.25
	Outer buffer	1.25
Perimeter		12.5

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Table 5. Exotic Retail Nursery Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0			Bull's-eye = 0.8	
1st buffer = 0.05	0.5	1.0	Areawide • Interior = 0.1 • Perimeter = 0.5	0.5
Outer buffer = 0.01				

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Relative Risk Index
Bull's-eye	Core	2000
	1st buffer	100
	Outer buffer	20
Areawide		
Interior	Core	250
	1st buffer	12.5
	Outer buffer	2.5
Perimeter		12.5

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

General Retail Stores (selling nursery stock)

These hardware, supermarket, and variety retail stores sell nursery stock.

- P_1 and P_5: The expert group believed that these values would be the same as those for general retail nursery.

- P_2: The expert group believed that exposure would be one-half (value of 0.25) of that for general retail nursery because trees are generally fewer and smaller, producing less shade canopy and fewer fruits, and sale areas are generally located within large, open parking areas.

- P_3: From experience, the expert group assumed that general retail stores carry a limited variety of fruit trees. Most are orange and other citrus, so the relative value for fair hosts is assigned to P_3.

- P_4: Assuming that people generally drove short distances to these stores, the expert group estimated low values.

Risk estimates and calculations for general retail stores are in table 6.

Table 6. General Retail Store (with nursery stock) Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0	0.25	0.1	Bull's-eye • Core & 1st buffer = 0.25 • Outer buffer = 0.4 Areawide • Interior = 0.01 • Perimeter = 0.5	0.5
1st buffer = 0.05				
Outer buffer = 0.01				

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Relative Risk Index
Bull's-eye	Core	31.25
	1st buffer	1.56
	Outer buffer	< 1.0
Areawide		
Interior	Core	1.25
	1st buffer	< 1.0
	Outer buffer	< 1.0
Perimeter		< 1.0

* Multiplied by 10,000 to create an index where few of its values drop below 1.0.

Wholesale Nurseries

This subgroup also includes mail-order nurseries.

- P_1 and P_3: The expert group assumed these parameters were the same as those for general retail nursery.

- P_2: The expert group assumed wholesale nurseries would have more shade and fruit than general retail nurseries do to attract flies, but the fruit would be less ripe than those on yard trees. The estimate was 0.75.

- P_4: Trees were assumed to be commonly moved 20 miles or more.

- P_5: Shipment size from wholesale nurseries was assumed to be large (e.g., 50 peach trees with possibly ± 40 kg of fruit per shipment); therefore, a shipment is estimated to have 10 times the risk of colonizing as one lot of yard fruit has.

For wholesale nursery risk estimates and calculations, see table 7.

Table 7. Wholesale Nursery Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0			Bull's-eye = 0.8	
1st buffer = 0.05	0.75	1.0	Areawide • Interior = 0.1	10
Outer buffer = 0.01			• Perimeter = 0.5	

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Relative Risk Index
Bull's-eye	Core	60,000
	1st buffer	3,000
	Outer buffer	600
Areawide		
Interior	Core	7,500
	1st buffer	375
	Outer buffer	75
Perimeter		375

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Orchard Group

Orchard group includes abandoned orchards, research plantings, and commercial orchards, large and small.

Abandoned Orchards

Few abandoned orchards exist because of high land prices where outbreaks have occurred in California. Those abandoned are citrus and olive orchards in southern California and stone fruit in northern California. Avocado orchards could be abandoned. The experts noted that lack of water in southern California produces few harvestable fruit. Abandoned citrus also produce poor fruit. Abandoned olive orchards can produce good fruit but are difficult for the lay person to pick. Olive fruit are normally processed shortly after harvest. Risk estimates and calculations (table 8) follow the assumptions.

- P_1: The relative probability of adult flies being in the area was estimated previously. Orchards can be present in each of the program zones.

- P_2: The expert group estimated that the degree of fruit exposure would be the same as those for yard fruit, 1.0.

- P_3: Abandoned orchard fruit could be good, fair, or poor hosts, so all three values are possible (1.0, 0.1, or 0.001, respectively).

- P_4: The expert group indicated a large amount of uncertainty when they developed these estimates.

- P_5: Because abandoned orchards produce few harvestable fruit, the amount of fruit per lot leaving the quarantine area is similar to amounts for one fruit lot from a yard. The much larger lot sizes of olive fruit do not contribute more significant risk because it is quickly processed.

Table 8. Abandoned Orchard Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0		Good = 1.0	Bull's-eye = 0.7	
1st buffer = 0.05	1.0	Fair = 0.1	Areawide • Interior = 0.1	1.0
Outer buffer = 0.01		Poor = 0.001	• Perimeter = 0.5	

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Host Preference	Relative Risk Index
Bull's-eye	Core	Good	7,000
		Fair	700
		Poor	7
	1st buffer	Good	350
		Fair	35
		Poor	< 1.0
	Outer buffer	Good	70
		Fair	7
		Poor	< 1.0
Areawide			
Interior	Core	Good	1,000
		Fair	100
		Poor	1.0
	1st buffer	Good	50
		Fair	5
		Poor	< 1.0
	Outer buffer	Good	10
		Fair	1.0
		Poor	< 1.0
Perimeter		Good	50
		Fair	5
		Poor	< 1.0

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

- P_1, P_2, P_3, and P_4: The expert group believed these parameters would be the same as those for abandoned orchards.

- P_5: Research plots can produce large amounts of fruit (compared to yards). Often this fruit is sold to commercial entities and sold or given away to employees and other individuals. Because research plot size can vary greatly, values based on plot size have been estimated for this parameter: small plots have 10 times the relative risk of a yard (10), while large plots have 100 times (100).

See risk estimates and calculations for research plantings in table 9.

Table 9. Research Planting Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0		Good = 1.0	Bull's-eye = 0.7	Large plot = 100
1st buffer = 0.05	1.0	Fair = 0.1	Interior = 0.1	
Outer buffer = 0.01		Poor = 0.001	Perimeter = 0.5	Small plot = 10

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Host Preference	Relative Risk Index	
			Large Plot	Small Plot
Bull's-eye	Core	Good	700,000	70,000
		Fair	70,000	7,000
		Poor	700	70
	1st buffer	Good	35,000	3,500
		Fair	3,500	350
		Poor	35	3.5
	Outer buffer	Good	7000	700
		Fair	700	70
		Poor	7	< 1.0
Areawide				
Interior	Core	Good	100,000	10,000
		Fair	10,000	1,000
		Poor	100	10
	1st buffer	Good	5000	500
		Fair	500	50
		Poor	5	< 1.0
	Outer buffer	Good	1,000	100
		Fair	100	10
		Poor	1	< 1.0
Perimeter		Good	5,000	500
		Fair	500	50
		Poor	5	< 1.0

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Commercial Orchards (Large)

These orchards produce fruits destined to packinghouses or processing plants. The risk associated with the fruit becoming infested after it arrives at the packinghouse or processing plant is covered under their respective sections. The risk associated with commercial orchards has two components: one from fruit that leave the quarantine area destined to a packinghouse or processing plant, and the other from fruit diverted from its normal use. For example, fruit may be taken from the orchard by orchard employees or given away by the orchard owner or manager. Fruit diverted by harvesters is covered under Wholesale Fruit Handlers—Harvesters. Before risk management requirements are in place, most of the risk is from the large amount of fruit destined for the packinghouse or for processing. The risk posed by fruit taken or given away is relatively small in comparison, but may be harder to manage.

Common hosts in California outbreak areas are orange, grapefruit, avocado, pepper, and peach. See risk estimates and calculations in table 10.

- P_1, P_2, and P_3: the same as those for abandoned orchards.
- P_4: Because almost all packinghouses and processing plants are outside areas of current and past outbreaks, a value of 0.9 is assigned.
- P_5: Without regulatory restriction, this pathway would represent the highest risk. Risk is assessed for the crop that can be harvested in one orchard in a week or less. A rough estimate was calculated as follows: one box is twice that of a yard fruit lot, which has a P_5 of 1, a thousand boxes fit in a 40-ft trailer, and five trailers of fruit can be harvested from a large commercial orchard, giving a P_5 of 10,000.

Table 10. Large Commercial Orchard Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0		Good = 1.0		
1st buffer = 0.05	1.0	Fair = 0.1	0.9	10,000
Outer buffer = 0.01		Poor = 0.001		

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Host Preference	Relative Risk Index
Bull's-eye and Areawide	Core	Good	9×10^7
		Fair	9×10^6
		Poor	9×10^4
	1st buffer	Good	4.5×10^6
		Fair	4.5×10^5
		Poor	4.5×10^3
	Outer buffer and Perimeter	Good	9×10^5
		Fair	9×10^4
		Poor	900

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Commercial Orchards (Small)

These orchards produce fruit for farmer's markets.

- P_1, P_2, and P_3 values are the same as those for abandoned orchards.
- P_4: The expert group estimated the likelihood of fruit leaving the area.
- P_5: The group estimated lot size would be about 20 boxes for a small orchard in a harvest period of a week or less. With probability of colonization for one box twice that of a yard fruit lot, P_5 is 40.

For risk estimates and calculations in small commercial orchards, see table 11.

Table 11. Small Commercial Orchard Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0		Good = 1.0	Bull's-eye = 0.8	
1st buffer = 0.05	1.0	Fair = 0.1		40
Outer buffer = 0.01		Poor = 0.001	Areawide = 0.05	

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Host Preference	Relative Risk Index
Bull's-eye	Core	Good	3.2×10^5
		Fair	32,000
		Poor	320
	1st buffer	Good	16,000
		Fair	1,600
		Poor	16
	Outer buffer	Good	3,200
		Fair	320
		Poor	3.2
Areawide			
Interior	Core	Good	2.0×10^5
		Fair	20,000
		Poor	200
	1st buffer	Good	10,000
		Fair	1,000
		Poor	10
	Outer buffer	Good	2,000
		Fair	200
		Poor	2
Perimeter		Good	2,000
		Fair	200
		Poor	2

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Nonresidential Landscape Fruit Trees

Grown mainly for ornamental purposes or shade, these trees are associated with zoos, theme parks, golf courses, garden parks, city parks, campuses, business properties, and arboretums. Except for P_2, the degree of fruit exposure, the parameters vary greatly with each situation. One zoo may have large numbers of fruit trees planted on its grounds; the next zoo, none. Because the number of fruit trees could vary, the regulatory officer will evaluate each establishment separately on a worksheet (see fig. 4).

- P_1: The relative probabilities of adult flies being in the area is as estimated previously.
- P_2: The expert group estimated that this parameter for nonresidential landscape fruit would be the same as that for a yard, thus 1.0.
- P_3: The relative probabilities were developed previously.
- P_4: The regulatory officer assesses the value of this parameter. The officer assesses the probability that the fruit will be harvested and moved off of the property and if so, the probability that it is moved out of the quarantine area. The product of these values is P_4.
- P_5: Determined from the worksheet based on the number of fruiting trees.

After completing the worksheet, the officer can describe the risk index qualitatively relative to other risk values in this assessment as follows:

10,000 and up	Very high
9,999 to 800	High
799 to 10	Moderate
9 to < 1	Low

Residential Hosts

This group is predominantly residential gardens, including community gardens. Because the expert group believes the risk from a community garden is about the same as that for a large yard containing several fruit trees, community gardens are not assessed separately. In the current outbreak in southern California, 47 community gardens are regulated—about 9 have fruit trees and all have pepper and tomato plants. Risk is assessed for movement of one fruit lot per yard per day. The assessment is limited to fruit given to friends or relatives. Fruit grown in yards that is sold, removed by yard maintenance, or discarded in garbage is assessed elsewhere in this document.

- P_1: Relative probabilities for adult Medfly presence in each program zone have been estimated.
- P_2: This is 1.0 by definition (See discussion of P_2 beginning on p. 9).

Figure 4. Nonresidential Landscape Fruit Trees—Assessment Worksheet

Property Name _____

Location _____

Date _____ Officer name _____

P_1: Probability flies are in area P_1 = _____

Program zone	P_1
☐ Core	1.0
☐ 1st Buffer	0.05
☐ Outer Buffer/Perimeter	0.01

P_2: Probability fruit is exposed P_2 = 1

P_3: Probability unauthorized person picks fruit P_3 = _____

Assign P_3 the Medfly host preference value for fruit that people will most likely pick. For example, a small college has 10 avocado trees (poor host) and a patch of *Opuntia* (fair host). Because the public is more likely to pick avocadoes than *Opuntia* fruit, assign 0.001 to P_3. *Opuntia*, olives, and ornamentals are generally not picked.

Host fruit most likely to be picked _____

Host	P_3
☐ Good	1.0
☐ Fair	0.1
☐ Poor	0.001

P_4: Probability fruit leaves quarantine P_4 = _____

	Probability fruit is moved off of property (0 to 1.0, 1 for most likely)	×	Probability moved-fruit leaves quarantine area (0 to 1.0, 1 for most likely)
P_4 =	_____	×	_____

P_5: Probability fruit causes outbreak P_5 = _____

No. of fruiting trees at location	P_5
☐ 1 to 3	2.0
☐ 4 to 10	5.0
☐ 10 to 50	25.0
☐ If 50+, then no. of trees _____ × 0.5 =	_____

Relative Risk Index = $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000^*$ = _____

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

- P_3: Depends on whether the residential host is a good, fair, or poor host. All three types are commonly grown in California yards. Table 3 lists host preferences for fruits commonly grown and marketed in the Los Angeles area.

- P_4: The experts derived these estimates after reviewing a Medfly residential quarantine notification report (California Department of Food and Agriculture 1992), and discussing their experiences in outbreaks.

- P_5: This is 1.0 as defined for a large personal fruit lot of about 4 kg (p. 11).

Although the risk of one yard is relatively low, total risk from all yards is of great significance because of the estimated 3 million yards in the current quarantine area. See risk estimates and calculations in table 12.

Table 12. Residential Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0		Good = 1.0	Bull's-eye = 0.05	
1st buffer = 0.05	1.0	Fair = 0.1	Areawide • Interior = 0.01	1.0
Outer buffer = 0.01		Poor = 0.001	• Perimeter = 0.05	

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Host Preference	Relative Risk Index
Bull's-eye	Core	Good	500
		Fair	50
		Poor	< 1.0
	1st buffer	Good	25
		Fair	2.5
		Poor	< 1.0
	Outer buffer	Good	5
		Fair	< 1.0
		Poor	< 1.0
Areawide			
Interior	Core	Good	100
		Fair	10
		Poor	< 1.0
	1st buffer	Good	5
		Fair	< 1.0
		Poor	< 1.0
	Outer buffer	Good	1.0
		Fair	< 1.0
		Poor	< 1.0
Perimeter		Good	5
		Fair	< 1.0
		Poor	< 1.0

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Retail Fruit Handlers Group

These retail fruit handlers include supermarkets, convenience stores, small groceries, farmer's markets or fruit stands, yard sales, and mobile and pushcart vendors. Unless stated otherwise, the risk measured here is from postharvest infestation; that is, fruit becomes infested after delivery to the retail handler.

Supermarkets

- P_1: The relative probability of adults being in the area has been estimated.
- P_2: The degree of fruit exposure inside supermarkets is limited: the fruits are within a closed building, doors generally close automatically, the building is generally air-conditioned, the fruit may be in open coolers, and the building is commonly surrounded by parking lots and other buildings. These factors contribute to a very unfavorable environment for Medfly. No evidence was found for the weak-flying, wild Medfly being associated with supermarket fruit. P_2 was estimated with difficulty and much uncertainty.
- P_3: All supermarkets sell several good hosts, so the highest value, 1.0, is given for host preference.
- P_4: The expert group assumed the great majority of people shopped at supermarkets close to their homes.
- P_5: As defined for one small personal lot of about 2 kg on page 12.

For supermarket risk estimates and calculations, see table 13.

Table 13. Supermarket Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0	0.0001 to 0.00001	1.0	Bull's-eye • Core & 1st buffer = 0.25 • Outer buffer = 0.4 Areawide • Interior = 0.01 • Perimeter = 0.4	0.5
1st buffer = 0.05				
Outer buffer = 0.01				

B. Relative Risk Index ($P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000^*$) = < 1.0 for all program zones.

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Convenience Stores

- P_1, P_2, and P_4: The expert group believed these values would be the same as those for supermarkets.
- P_3: Most convenience stores carry a limited amount and type of fruit. Examples are avocado and apple. These stores rarely carry good Medfly hosts. Hosts are generally fair; thus a value of 0.1 is given.

- P_5: Generally only one to a few fruits are bought at one time from a convenience store, so P_5 is estimated as one-half that for supermarkets.

With reduced values for P_3 and P_5, the risk from convenience stores is much less than that from supermarkets. The relative risk index for all scenarios is less than 1.

Small Groceries

This subgroup includes "mom and pop" stores and neighborhood groceries. These stores may reflect the ethnic character of the neighborhood.

- P_1, P_3, P_4, and P_5: The expert group believed these would be the same as those for supermarkets.

- P_2: Preharvest exposure—the expert group identified the possibility that fruit sold in a small grocery could have been harvested from a yard. These yards are commonly located within the quarantine area and may be infested. The expert group estimated preharvest exposure would range between 0.01 and 0.001, that is one fruit between a hundred to a thousand in the store would be from a yard.

  Postharvest exposure—the degree of exposure for fruit at a small grocery is much greater than at supermarkets. The doors may not close automatically and may be kept open. The store may not be air-conditioned, and the fruit may not be kept in coolers. The small stores will generally be found close to yard trees. Because of the above factors, the group estimated that P_2 for postharvest exposure would be 10 times greater than supermarket values, between 0.001 to 0.0001.

  The highest values of P_2 for preharvest (0.01) and postharvest (0.001) were then combined for a P_2 of 0.011.

For small-grocery risk estimates and calculations, see table 14.

Farmer's Market or Fruit Stands

This subgroup includes fruit stands set up within swap meets, fairs, or other open air locations. Those who sell yard fruit are not assessed in this section but under Yard Sales.

- The expert group believed P_1, P_3, and P_5 are the same as those for supermarkets. The experts believed fruit grown in yards would not be sold here, so the risk assessment involves only postharvest exposure.

- P_2: Before regulatory restrictions are in place, fruit would be physically exposed. Farmer's markets or fruit stands are usually set up in a parking lot, and shade trees (in some cases, fruit trees) may grow nearby. Although the fruit may be near an infested area, the expert group believed Medfly would seldom fly to this fruit (Medfly is a weak flier that avoids sun.). The group estimated P_2 with a large amount of uncertainty.

Table 14. Small Grocery Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0 1st buffer = 0.05 Outer buffer = 0.01	Preharvest = 0.01 to 0.001 Postharvest = 0.001 to 0.0001	1.0	Bull's-eye • Core & 1st buffer = 0.25 • Outer buffer = 0.4 Areawide • Interior = 0.01 • Perimeter = 0.4	0.5

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Relative Risk Index
Bull's-eye	Core	13.8
	1st buffer	< 1.0
	Outer buffer	< 1.0
Areawide	All	< 1.0

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Table 15. Farmer's Market or Fruit Stand Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0 1st buffer = 0.05 Outer buffer = 0.01	0.01 to 0.001	1.0	Bull's-eye = 0.5 Areawide • Interior = 0.075 • Perimeter = 0.5	0.5

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Relative Risk Index
Bull's-eye	Core	25
	1st buffer	1.25
	Outer buffer	< 1.0
Areawide		
Interior	Core	3.75
	1st buffer	< 1.0
	Outer buffer	< 1.0
Perimeter		< 1.0

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

- P_4: The expert group estimated with a large degree of uncertainty the probability that farmer's market fruit leaves the quarantine area.

See risk estimates and calculations for farmer's market or fruit stands in table 15.

Yard Sales

Yard sales include "small fruit stands" in front of a residence, fruit sold at a yard sale along with other items, or yard fruit sold at a swap meet by an individual along with other nonfood articles. All fruit sold here is picked from a yard. See risk estimates and calculations in table 16.

- P_1, P_4, and P_5: The expert group believed that the values for yard sales have the same values as those for farmer's markets.
- P_2: Because the fruit is mostly from yards in the quarantine area, P_2 is estimated as 1.0.
- P_3: A limited amount and number of fruit species are sold in this manner, such as only tomato or avocado or a few host species per yard sale. Hosts can be good, fair, or poor, giving three possible values to P_3.

Table 16. Yard Sale Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0		Good = 1.0	Bull's-eye = 0.5	
1st buffer = 0.05	1.0	Fair = 0.1	Areawide • Interior = 0.075	0.5
Outer buffer = 0.01		Poor = 0.001	• Perimeter = 0.5	

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Host Preference	Relative Risk Index
Bull's-eye	Core	Good	2,500
		Fair	250
		Poor	2.5
	1st buffer	Good	125
		Fair	12.5
		Poor	< 1.0
	Outer buffer	Good	25
		Fair	2.5
		Poor	< 1.0
Areawide			
Interior	Core	Good	375
		Fair	37.5
		Poor	< 1.0
	1st buffer	Good	18.8
		Fair	1.9
		Poor	< 1.0
	Outer buffer	Good	3.8
		Fair	< 1.0
		Poor	< 1.0
Perimeter		Good	25
		Fair	2.5
		Poor	< 1.0

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Mobile Vendors

This handler sells fruit at retail from either pickup trucks or panel vans. This fruit comes from commercial orchards, not yards, so only postharvest exposure will be assessed here. Postharvest exposure can occur either during the period of sales (e.g., 8:00 a.m. to 4:00 p.m.) or during storage of fruit at the vendor's home. Unsold fruit is left in the pickup or put in the shade of a carport or tree.

- P_1, P_3, and P_5 values for mobile vendor are the same as those for farmer's market values.

- The expert group developed the following scenarios, each with its own P_2 and P_4 values, except scenario C, which also has its own P_5.

Bull's-eye Program Scenarios

A: Mobile vendor sells and holds fruit within the quarantine area.
- $P_2 = 0.01$ during sales time and 0.1 during storage at seller's home, totaling 0.11.
- $P_4 = 0.6$

B: Sells within quarantine area but holds fruit outside of quarantine area.
- $P_2 = 0.01$ (exposure only during sales time)
- $P_4 = 0.8$

C: Sells outside of quarantine area but holds unsold fruit within the quarantine area. A large amount of fruit is exposed to attack and then sold outside of the area; thus P_5 is much larger than those for scenarios A, B, D, or E.
- $P_2 = 0.1$
- $P_4 = 1.0$ by the description of this scenario
- $P_5 = 5$, roughly estimated as 10 times a small personal fruit lot

Areawide Program Scenarios

D: Sells within interior of quarantine area.
- P_2 = same as for scenario A
- $P_4 = 0.01$

E: Sells within perimeter of quarantine area.
- P_2 = same as for scenario A
- $P_4 = 0.025$

For mobile-vendor risk estimates and calculations, see table 17.

Pushcart Vendors

This subgroup also includes roadside sales where no pushcart is used. Sales may be directly to people in cars. The fruit is in plastic bags on the ground. Generally, the vendors sell one or two types of fruit—mostly oranges, apples, or mangoes, rarely stone fruits. The fruit is from commercial groves, most of it from the Central Market (a wholesale market in Central Los Angeles) with some fruit from Bakersfield. Only postharvest exposure is assessed.

Table 17. Mobile Vendor Risks

A. Scenario Probabilities

P_1: flies in area*	P_3: flies infest fruit	P_2: fruit exposed		P_4: fruit leaves area		P_5: flies colonize
		Bull's-eye				
Core = 1.0		• S(A) = 0.11	×	0.6	×	0.5
		• S(B) = 0.01	×	0.8	×	0.5
1st buffer = 0.05	1.0	• S(C) = 0.1	×	1.0	×	5.0
		Areawide				
Outer buffer = 0.01		• S(D) = 0.11	×	0.01	×	0.5
		• S(E) = 0.11	×	0.025	×	0.5

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$†

Program	Zone	Relative Risk Index
Bull's-eye		
• S(A)	Core	330
	1st buffer	16.5
	Outer buffer	3.3
• S(B)	Core	40
	1st buffer	2
	Outer buffer	< 1.0
• S(C)	Core	5,000
	1st buffer	250
	Outer buffer	50
Areawide		
• S(D)	Core	5.5
	1st buffer	< 1.0
	Outer buffer	< 1.0
• S(E)	Outer buffer	< 1.0

* Use the higher P_1 value if sales and holding areas are in separate zones: core, 1st buffer, or outer buffer

† Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

- P_1 and P_5 values for pushcart vendors are the same as those for farmer's market.
- P_2: Because these vendors sell a smaller volume of fruit than mobile vendors do and the amount stored during nonsales time is much less, roughly one-half the value of P_2 for mobile vendors is estimated for this P_2.
- P_3: A value of 0.1 is given because orange, mango and apple are fair hosts.
- P_4: The expert group estimated likelihoods of fruit leaving each zone.

For pushcart vendor risk estimates and calculations, see table 18.

Table 18. Pushcart Vendor Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0			Bull's-eye = 0.5	
1st buffer = 0.05	0.05	0.1	Areawide • Interior = 0.05	0.5
Outer buffer = 0.01			• Perimeter = 0.5	

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Relative Risk Index
Bull's-eye	Core	12.5
	1st buffer	< 1.0
	Outer buffer	< 1.0
Areawide		
Interior	Core	1.25
	1st buffer	< 1.0
	Outer buffer	< 1.0
Perimeter		< 1.0

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Wholesale Fruit Handlers Group

This group includes packinghouses, distributors, foodbanks, haulers, processors, receivers, and harvesters. High-exposure facilities are open and within 100 yards of fruiting host trees while low-exposure facilities are not. Shippers of transient loads (shipments from packinghouse to Central Market) are regulated indirectly, under compliance agreement with the wholesale fruit handler receiving the fruit, and are assessed under the handler (e.g., distributors, processors, etc.).

Packinghouses

- P_1: Relative probability of adult flies in the area was previously estimated.
- P_2: The expert group estimated with a larger amount of uncertainty that high-exposure packinghouses have P_2 values of 0.01 to 0.001, and low-exposure packinghouses values range 10 times lower. Only the higher estimates for P_2 are used in the calculation section of table 19. Only postharvest exposure is assessed here; preharvest exposure was assessed elsewhere.
- P_3: Some packinghouses pack only one type of fruit. Others pack a few types, whatever is in season. P_3 values depend on which host type is being packed at a house during a specific time of year.
- P_4: Most produce packed at the houses within the quarantine area are destined for shipment out of the area. The expert group based their P_4 estimates on this knowledge for both programs (Bull's-eye value of 0.98 was rounded to 1.0 for calculation purposes). Areawide values are 80 percent of bull's-eye.

- P_5: Under the worst packinghouse conditions, only a limited amount of host material will be exposed to the small fly number. P_5 was estimated with much uncertainty as 20 times the value of a supermarket lot (0.5) for a P_5 of 10.

For packinghouse risk estimates and values, see table 19.

Table 19. Packinghouse Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0	Exposure high = 0.01 to 0.001	Good = 1.0	Bull's-eye = 1.0	10
1st buffer = 0.05	Low exposure = 0.001 to 0.0001	Fair = 0.1	Areawide = 0.8	
Outer buffer = 0.01		Poor = 0.001		

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Host Preference	Relative Risk Index	
			High Exposure	Low Exposure
Bull's-eye	Core	Good	1,000	100
		Fair	100	10
		Poor	1	< 1.0
	1st buffer	Good	50	5
		Fair	5	< 1.0
		Poor	< 1.0	< 1.0
	Outer buffer	Good	10	1.0
		Fair	1	< 1.0
		Poor	< 1.0	< 1.0
Areawide				
Interior	Core	Good	800	80
		Fair	80	8
		Poor	< 1.0	< 1.0
	1st buffer	Good	40	4
		Fair	4	< 1.0
		Poor	< 1.0	< 1.0
	Outer buffer	Good	8	< 1.0
		Fair	< 1.0	< 1.0
		Poor	< 1.0	< 1.0
Perimeter		Good	8	< 1.0
		Fair	< 1.0	< 1.0
		Poor	< 1.0	< 1.0

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Distributors

Most of these wholesale fruit sellers in the current areawide program are located in the Central Market area. Little of the host fruit is exposed to attack by Medfly here: 5 percent of the fruit is repacked and 90 percent of the repacking occurs at night when fruit flies are inactive.

- P_1, P_2, and P_5: The expert group believed these distributor values are the same as those for packinghouse.

- P_3: Because all or most distributors carry assorted fruits including some good hosts at any point in time, P_3 is given as 1.0.

- P_4: Thinking these values would be about the same as those for packinghouses, the expert group made their estimates with a large amount of uncertainty (The 0.98 for bull's-eye was rounded to 1.0 for calculation purposes.).

For distributor risk estimates and values, see table 20.

Table 20. Distributor Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0	Exposure high = 0.01 to 0.001	1.0	Bull's-eye = 1.0	10
1st buffer = 0.05	Exposure low = 0.001 to 0.0001		Areawide = 0.6	
Outer buffer = 0.01				

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Relative Risk Index	
		High Exposure	Low exposure
Bull's-eye	Core	1,000	100
	1st buffer	50	5
	Outer buffer	10	1
Areawide			
Interior	Core	600	60
	1st buffer	30	3
	Outer buffer	6	< 1.0
Perimeter		6	< 1.0

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Foodbanks

The expert group identified foodbanks as small distributors basically. The size of foodbanks and number of boxes of host fruit (20 to 400 boxes) vary greatly. For foodbank risk estimates and values, see table 21.

- P_1, P_2, P_3, and P_5: The expert group assumed these would be the same as those for distributors.

- P_4: Most foodbanks are located within the interior of the current areawide program. They generally distribute food locally. Estimates for produce leaving the quarantine area had a large degree of uncertainty.

Table 21. Foodbank Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0	Exposure high 0.01 to 0.001	1.0	Bull's-eye • Core & 1st buffer = 0.2 • Outer buffer = 0.4	10
1st buffer = 0.05				
Outer buffer = 0.01	Exposure low 0.001 to 0.0001		Areawide = 0.05	

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Relative Risk Index	
		High Exposure	Low Exposure
Bull's-eye	Core	200	20
	1st buffer	10	1
	Outer buffer	4	< 1.0
Areawide			
Interior	Core	50	5
	1st buffer	2.5	< 1.0
	Outer buffer	< 1.0	< 1.0
Perimeter		< 1.0	< 1.0

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Haulers

For assessment purposes, this risk subgroup only covers haulers that haul culled fruit and unprocessed or underprocessed fruit or waste from a processing plant, distributor, or packinghouse. The culled fruit and waste are destined as animal food within the quarantine area or to waste disposal sites. Excluded are haulers that haul out of the quarantine area, byproducts (completely processed) from processing plants (that risk is assessed under processor or receiver), and haulers that haul fruit waste mixed with other garbage from either commercial or residential establishments (that risk is assessed under waste disposal sites). The risk assessed in this section is concerned with the possibility of fruit culls and waste either being diverted out of quarantine areas or not buried in a landfill. This subgroup is further divided into high-risk haulers (who haul fruit products subject to attack at preharvest), and low-risk haulers (who may haul products attacked at postharvest).

High-risk Haulers

High-risk haulers deal with culled fruit and unprocessed waste from fruit grown within the quarantine area. This fruit was not subject to treatment.

- P_1: Depends in which program zone the fruit was grown.
- P_2: Preharvest exposure here is the same as that in commercial orchards.
- P_3: Depends under which of three host preference categories the fruit grown within the quarantine area falls.

- P_4: At the beginning of a program before haulers are placed under compliance agreements, the probability that the high-risk hauler leaves the quarantine area will be high. The estimates have a large degree of uncertainty (Bull's-eye at 0.98 was rounded off to 1.0 for calculation purposes).

- P_5: The amount of infested fruit that could leave under this scenario is large, about 10 times that of a distributor. This estimate has much more uncertainty.

Risk estimates and values for high-risk-haulers are in table 22.

Table 22. High-risk Hauler Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0		Good = 1.0	Bull's-eye = 1.0	
1st buffer = 0.05	1.0	Fair = 0.1		100
Outer buffer = 0.01		Poor = 0.001	Areawide = 0.8	

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Host Preference	Relative Risk Index
Bull's-eye	Core	Good	1×10^6
		Fair	1×10^5
		Poor	1,000
	1st buffer	Good	50,000
		Fair	5,000
		Poor	50
	Outer buffer	Good	10,000
		Fair	1,000
		Poor	10
Areawide			
Interior	Core	Good	8×10^5
		Fair	8×10^4
		Poor	800
	1st buffer	Good	40,000
		Fair	4,000
		Poor	40
	Outer buffer	Good	8,000
		Fair	800
		Poor	8
Perimeter		Good	8,000
		Fair	800
		Poor	8

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Low-risk Haulers

- P_1 and P_3: Because these haulers can haul from establishments within quarantine areas (including the core) and will sometimes haul at least some good hosts, P_1 and P_3 should be 1.0.

- P_2 and P_5: Low-risk haulers handle fruit exposed only to postharvest attack; thus, we can assume that P_2 would be 0.01 or less and that P_5 would be about 10 (See Distributor and Packinghouse in this group).

- P_4 for low-risk hauler would be the same as that for high-risk hauler.

Risk estimates and values for low-risk haulers appear in table 23.

Table 23. Low-risk Hauler Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
1.0	0.01	1.0	Bull's-eye = 1.0 Areawide = 0.8	10

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Relative Risk Index
Bull's-eye	1000
Areawide	800

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Processors

This subgroup includes food processors within the quarantine area that use Medfly host fruits grown within the quarantine area. With no preharvest or postharvest treatment required, the fruit could be infested. The major risk will be from preharvest infestation. The processor produces canned fruit, juice, or other processed products. Most or all operations eliminate skin, seeds, pulp, or other byproducts. Because regulatory risk managers are responsible for determining that these products and byproducts will be free of live Medfly, these items/processes are not part of this assessment. Culled fruit and unprocessed or underprocessed waste hauled away for animal food or to a waste disposal site are assessed under Haulers. Two risk factors are assessed here: 1) whole fruit removed from the processing plant by workers or management for personal use or even for sale, and 2) movement of trucks and field crates containing pupae and late instar larvae.

- P_1: Assumes the value for the program zone where the fruit was grown. The processor may process fruit grown in one zone (e.g., outer buffer) or all three program zones.

- P_2: Deals with preharvest exposure of commercially grown fruit, so its value is 1.0.

- P_3: Depends on the processor and where in the quarantine area the fruit was grown and the host fruit preference categories he handles.

- P_4: This parameter is most difficult to assess and has a large degree of uncertainty. Because P_4 covers the risk of Medfly contaminating truck and field boxes, as well as whole fruit,, the model used for the assessment of processors is not completely appropriate.

- P_5: Again, with a large amount of uncertainty, this value is set at 10.

For processor risk estimates and values, see table 24. Risk under areawide program in the interior is 20 percent of the other zones.

Table 24. Processor Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0		Good = 1.0	Bull's-eye = 0.8	
1st buffer = 0.05	1.0	Fair = 0.1	Areawide • Interior = 0.16	10
Outer buffer = 0.01		Poor = 0.001	• Perimeter = 0.8	

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Host Preference	Relative Risk Index
Bull's-eye	Core	Good	8×10^4
		Fair	8,000
		Poor	80
	1st buffer	Good	4,000
		Fair	400
		Poor	4
	Outer buffer	Good	800
		Fair	80
		Poor	< 1
Areawide			
Interior	Core	Good	1.6×10^4
		Fair	1,600
		Poor	16
	1st buffer	Good	800
		Fair	80
		Poor	< 1
	Outer buffer	Good	160
		Fair	16
		Poor	< 1
Perimeter		Good	800
		Fair	80
		Poor	< 1

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Receivers

Located outside the quarantine area, receivers are defined as persons that receive processed byproducts from a food processing plant in a quarantine area. Although these byproducts are assumed to be pest free, PPQ limits types of usage to maintain a redundant safeguard. Byproducts can be used for animal food but not for compost around fruit trees, for example. Receivers are few, even in the current large outbreaks. Because the risk model used for the assessment is inappropriate for this pathway, a subjective rating of moderate risk has been developed for receiver.

Harvesters

The packinghouse or orchard contracts harvesters to hire and manage the laborers to pick and transport fruit to the packinghouse or processing plant. Most harvesters probably live far from the orchard. The risk associated with this subgroup is mainly from the harvester and his employees taking home small amounts of fruit-fly-exposed fruit. A secondary risk is from the possible contamination of the trucks with larvae that emerge during transit. Risks posed by orchard shipments leaving the quarantine area are covered under commercial orchards, but reducing that risk takes compliance by orchard and harvester.

- P_1: Depends in which program zones the fruit was grown.
- P_2: Preharvest exposure is the same as that in commercial orchards.
- P_3: Depends on which of three categories of host preference the fruit grown within the quarantine area falls.
- P_4: When a program begins, before harvesters are placed under compliance agreements, the probability that at least some of the fruit will be diverted and leave the quarantine area is high.
- P_5: The amount of infested fruit that could leave the quarantine area is large under this scenario. This estimate has much uncertainty.

For harvester risk estimates and values, see table 25.

Small-lot Commercial Conveyances

This group moves small lots of fruit by plane, train, bus, and government or commercial parcel delivery. The fruit lots are mostly part of passenger baggage or personal shipments of small parcels, but include crew baggage or airplane and possibly train stores. Most fruit associated with this group is yard fruit. Yard fruit moved by passenger car or local buses was assessed under "Residential Hosts." Most yard and commercial fruit (small lots) are moved out of the quarantine area by passenger car. This section assesses the risk of one unit of the above pathway, for example, one airport, one bus station, one parcel carrier facility.

- P_1: Location of the post office or bus station may relate poorly to where the fruit was grown. To assume the worse case value (core of 1.0) overestimates the risk for small-lot commercial conveyances, so an estimate of one-half is given for P_1 while acknowledging much uncertainty.

- P_2: Because most fruit is from yards, exposure is estimated as complete.

- P_3: Common fruits moved by these pathways are citrus, avocado, peach, persimmon, and fig, giving P_3 a high host-preference value.

- P_4: This fruit is associated with long-distance methods of conveyance, so by definition, all fruit leave the quarantine area.

Table 25. Harvester Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0		Good = 1.0	Bull's-eye = 0.8	
1st buffer = 0.05	1.0	Fair = 0.1		10
Outer buffer = 0.01		Poor = 0.001	Areawide = 0.5	

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Host Preference	Relative Risk Index
Bull's-eye	Core	Good	8×10^4
		Fair	8,000
		Poor	80
	1st buffer	Good	4,000
		Fair	400
		Poor	< 1
	Outer buffer	Good	800
		Fair	80
		Poor	< 1
Areawide			
Interior	Core	Good	5×10^4
		Fair	5,000
		Poor	50
	1st buffer	Good	2,500
		Fair	250
		Poor	< 1
	Outer buffer	Good	500
		Fair	50
		Poor	< 1
Perimeter		Good	500
		Fair	50
		Poor	< 1

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

- P_5: The larger small-lot commercial conveyances moving the most fruit, such as large airports or large post offices, tend to move this fruit to places within the United States where no colonization would occur. Smaller establishments, however, such as bus stations, train stations, and small regional airports, tend to move the fruit to locations within California, where colonization could occur. Considering that the above factors have a large degree of uncertainty, we estimated that 20 individuals per day per facility, each moving one residential fruit lot, would pose a risk 20 times that of a residential host assessment for all establishments in this group.

Because this factor deals basically with long-distance movement, the risk from bull's-eye and areawide programs will be about the same. Risk estimates and values of small-lot commercial conveyances appear in table 26.

Table 26. Small-lot Commercial Conveyance Risks

A. Scenario Probabilities				
P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
0.5	1.0	1.0	1.0	20
B. Relative Risk Index = results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000^* = 100{,}000$				

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Waste Disposal Sites

Waste disposal sites include two types: landfills and green waste recyclers.

Landfills

Landfills in the Los Angeles area are located outside the quarantine area but receive refuse from the quarantine area. State health requirements of covering trash and garbage with soil, and the lack of host plants in the general area of the landfill are assumed to limit the risk. Because the model for this assessment is inappropriate for this pathway, the number of landfills during an outbreak is limited, and the factors discussed above, landfills are assigned a qualitative rating of low risk with a moderate risk rating for landfills near fruit production areas.

Green Waste Recyclers

This subgroup receives plant waste from mainly residential properties directly or indirectly from yard maintenance personnel. This subgroup is not regulated by the same State health requirements as landfills are, so green waste need not be covered by soil daily.

The majority of green waste recycler risk would be posed by facilities outside of the quarantine area but within easy driving distance. A much lesser risk would be from sites within the quarantine area. From these sites, a new core area could develop, or fruit waste could be removed for other purposes (i.e., animal food) .

As with landfills, the model for the assessment is inappropriate for the green waste recycler pathway, so a qualitative risk rating was developed: low risk for sites inside the quarantine area of either program, and for sites outside of the program area—high for bull's-eye or moderate for areawide.

Yard Maintenance

This section assesses the risk of one fruit lot per day taken from residential or nonresidential properties by yard maintenance personnel. These fruits are given or "taken" for table use, have dropped as fruit debris, or are attached to branches trimmed during yard maintenance. Debris and branches disposed of legally at a waste disposal site are assessed above, so the majority of risk posed by yard maintenance would be workers removing fruit for consumption.

- P_1: Depends on the yard location in the program zone.
- P_2: With a large majority of the fruit from yards, this parameter would have a relative value of 1.0.
- P_3: Yard maintenance personnel will come into contact with a wide variety of fruits, so the highest value of 1.0 is given for this parameter.
- P_4: After discussing various experiences with yard maintenance personnel in current and past outbreaks, the experts assumed that 1 in 10 maintenance personnel would remove fruit from a property per day.
- P_5: The expert group assumed that lot size would be similar to lot sizes given to friends or relatives by a homeowner.

See risk estimates and values in table 27 for yard maintenance.

Table 27. Yard Maintenance Risks

A. Scenario Probabilities

P_1: flies in area	P_2: fruit exposed	P_3: flies infest fruit	P_4: fruit leaves area	P_5: flies colonize
Core = 1.0			Bull's-eye = 0.09	
1st buffer = 0.05	1.0	1.0	Areawide • Interior = 0.01	1.0
Outer buffer = 0.01			• Perimeter = 0.02	

B. Results of $P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times 10{,}000$*

Program	Zone	Relative Risk Index
Bull's-eye	Core	900
	1st buffer	45
	Outer buffer	9
Areawide		
Interior	Core	100
	1st buffer	5
	Outer buffer	1
Perimeter		2

* Multiplied by 10,000 to create a relative risk index where few of its values drop below 1.0.

Summary and Conclusions

The following tables summarize the relative risk of various regulatory activities that occur in California during a Medfly outbreak. The reader should remember that each risk value is for a single unit only (e.g., a fruit lot from one yard or one commercial orchard harvest).

Bull's-eye Program

Table 28 summarizes the relative risks of activities managed under a bull's-eye program. Because much of the evidence and experience of the experts dealt with outbreaks in the Los Angeles and the Santa Clara areas, CA, risk estimates for other areas would vary.

Table 28. Medfly Risks in California under a Bull's-eye Program

Risk	Regulated Activity	Host* of concern			Relative Risk Values
		Core	First Buffer	Outer Buffer	
Very High (10,000 and up)	Large commercial orchard	G F P ...	G F	G F	9×10^7 to 9×10^4
	High-risk hauler of fruit grown in zone	G F	G	G	1×10^6 to 1×10^4
	Large research planting	G F	G	... ...	7×10^5 to 3.5×10^4
	Small commercial orchard	G F	G	... ...	3.2×10^5 to 1.6×10^4
	Small-lot commercial conveyance	... ... A	... ... A	... ... A	1×10^5
	Harvester	G	... ...	... ...	8×10^4
	Processor of fruit grown in zone	G	... ...	... ...	8×10^4
	Small research planting	G	... ...	... ...	7×10^4
	Wholesale nursery	... ... A	... ...	... ...	6×10^4
	Nonresidential landscape fruit trees rated 10,000 or more in any zone	... ...	... ...	... ...	1×10^4 and up
High (9,999 to 800)	Harvester	... F	G	G	8,000 to 800
	Processor of fruit grown in zone	... F	G	G	8,000 to 800
	Abandoned orchard	G	... ...	... ...	7,000
	Large research planting	... ...	... F	G	7,000 to 3,500
	Small research planting	... F	G	... ...	7,000 to 3,500
	Mobile vendor sells outside of quarantine area but stores fruit in core	... ... A	... ...	... ...	5,000
	High-risk hauler of fruit grown in zone	... ... P ...	... F	... F	5,000 to 1,000
	Large commercial orchard	... ...	... ... P ...	... ... P ...	4,500 to 900
	Small commercial orchard	... ...	... F	G	3,200 to 1,600
	Wholesale nursery	... ...	... ... A	... ...	3,000
	High-risk yard sale	G	... ...	... ...	2,500
	Exotic retail nursery	... ... A	... ...	... ...	2,000
	General retail nursery	... ... A	... ...	... ...	1,250
	High-exposure distributor	... ... A	... ...	... ...	1,000
	High-exposure packinghouse	G	... ...	... ...	1,000
	Low-risk hauler	... . A	... ... A	... ... A	1,000

Table 28. Medfly Risks in California under a Bull's-eye Program—Continued

Risk	Regulated Activity	Host* of concern			Relative Risk Values
		Core	First Buffer	Outer Buffer	
High—Continued	Yard maintenance doing site in zone	... ... A	... ...	... ...	900
	Nonresidential landscape fruit trees rated 800–9,999 in any zone	... ...	... ...	... ...	800 to 9,999
	Green waste recycler located outside of quarantine area	... ...	... ...	... ...	Subjectively rated high
Moderate (799-10)	Small research planting	... ... P ...	... F	G F	700 to 70
	Abandoned orchard	... F	G F	G	700 to 35
	Large research planting	... ... P ...	... ... P ...	... F	700 to 35
	Wholesale nursery	... ...	... ...	... ... A	600
	High-risk resident	G	... ...	... ...	500
	Harvester	... ... P ...	... F	... F	400 to 80
	Processor of fruit grown in zone	... ... P ...	... F	... F	400 to 80
	Mobile vendor sells and stores fruit in core or 1st buffer	... ... A	... ... A	... ...	330 to 16.5
	Small commercial orchard	... ... P ...	... ... P ...	... F	320 to 16
	Mobile vendor stores fruit in either buffer but sells outside of quarantine area	... ...	... ... A	... ... A	250 to 50
	Moderate-risk yard sale	... F	G F	G	250 to 12.5
	High-exposure foodbank	... . A	... ... A	... ...	200 to 10
	Low-exposure distributor	... ... A	... ...	... ...	100
	Exotic retail nursery	... ...	... ... A	... ... A	100 to 20
	High-exposure packinghouse	... F	G	G	100 to 10
	Low-exposure packinghouse	G F	... ...	... ...	100 to 10
	General retail nursery	... ...	... ... A	... ... A	62.5 to 12.5
	Moderate-risk resident	... F	G	... ...	50 to 25
	High-exposure distributor	... ...	... ... A	... ... A	50 to 10
	High-risk hauler of fruit grown in zone	... ...	... ... P ...	... ... P ...	50 to 10
	Yard maintenance doing property in zone	... ...	... ... A	... ...	45
	Mobile vendor sells in core but stores fruit outside of quarantine area	... ... A	... ...	... ...	40
	General retail store selling nursery stock	... ... A	... ...	... ...	31.3
	Farmer's market, fruit stand	... ... A	... ...	... ...	25
	Low-exposure foodbank	... ... A	... ...	... ...	20
	Small grocery	... ... A	... ...	... ...	13.8
	Pushcart vendor, roadside sales	... ... A	... ...	... ...	12.5
	Nonresidential landscape fruit trees rated 10-799 in any zone	... ...	... ...	... ...	10 to 799
	Receiver is outside of quarantine area, receives byproducts from quarantine area	... ...	... ...	... ...	Subjectively rated moderate
	Landfill is outside of quarantine area but near fruit production, receives refuse from quarantine area	... ...	... ...	... .	Subjectively rated moderate

Table 28. Medfly Risks in California under a Bull's-eye Program—Continued

Risk	Regulated Activity	Host* of concern			Relative Risk Values
		Core	First Buffer	Outer Buffer	
Low (9 to < 1)	All other activities not mentioned under nursery group *(general retail store selling nursery stock)*, orchard group (*abandoned and small commercial orchards, research plantings*), nonresidential landscape fruit trees, residential, retail fruit group (*supermarkets—all, convenience stores — all, small groceries, farmer's market or fruit stands, yard sales, mobile vendors*), wholesale fruit handlers (*packinghouses, low-exposure distributors, foodbanks, haulers, processors, and harvesters*), waste disposal sites (*landfills* outside of quarantine area and not near fruit production, and *green waste recyclers* inside quarantine area), and yard maintenance.				

* Host preference in the specified zone: **A** any host—the activity handles fruits in predominantly one host preference category, so one host preference value was used to calculate risk, and the resulting risk value concerns any host. **G** good, **F** fair, or **P** poor—risk was calculated applying the three host preference values to each scenario.

Areawide Program

Table 29 summarizes the relative risk of various regulatory activities under an areawide program in the Los Angeles area. Because values for the parameter P_4, which is concerned with the probability of infested fruit leaving the quarantine area, are specific to the Los Angeles area, this table cannot be used for other areas.

Table 29. Medfly Risks in Los Angeles, CA, under an Areawide Program

Risk	Regulated Activity	Host* of concern				Relative Risk Values
		Core	First Buffer	Outer Buffer	Perim-eter	
Very High (10,000 and up)	Large commercial orchard	G F P ...	G F	G F	G F	9×10^7 to 9×10^4
	High-risk hauler of fruit grown in zone	G F	G	... ...	... ...	8×10^5 to 4×10^4
	Small commercial orchard	G F	G	... ...	... ...	2×10^5 to 1×10^4
	Small-lot commercial conveyance	... ... A	... ... A	... ... A	... ... A	1×10^5
	Large research planting	G F	... ...	... ...	... ...	1×10^5 to 1×10^4
	Harvester	G	... ...	... ...	... ...	5×10^4
	Processor of fruit grown in zone	G	... ...	... ...	... ...	1.6×10^4
	Small research planting	G	... ...	... ...	... ...	1×10^4
	Nonresidential landscape fruit trees rated 10,000 or more in any zone	... ...	... ...	... ...	... ...	1×10^4 and up
High (9,999 to 800)	High-risk hauler of fruit grown in zone	... ... P ...	... F	G F	G F	8,000 to 800
	Wholesale nursery	... ... A	... ...	... ...	... ...	7,500
	Harvester	... F	G	... ...	... ...	5,000 to 2,500
	Large research planting	... ...	G	G	G	5,000 to 1,000
	Large commercial orchard	... ...	... ... P ...	... ... P ...	... ... P ...	4,500 to 900
	Small commercial orchard	... ...	... F	G	G	2,000 to 1,000
	Processor of fruit grown in zone	... F	G	... ...	G	1,600 to 800
	Small research planting	... F	... ...	... ...	... ...	1,000
	Abandoned orchard	G	... ...	... ...	... ...	1,000
	Low-risk hauler from quarantine area	... ... A	... ... A	... ... A	... ... A	800
	High-exposure packinghouse	G	... ...	... ...	... ...	800
	Nonresidential landscape fruit trees rated 800-9,999 in any zone	... ...	... ...	... ...	... ...	800 to 9,999

Table 29. Medfly Risks in Los Angeles, CA, under an Areawide Program—Continued

Risk	Regulated Activity	Host* of concern				Relative Risk Values
		Core	First Buffer	Outer Buffer	Perim-eter	
Moderate (799 to 10)	High-exposure distributor	A	A			600 to 30
	Large research planting	P	F	F	F	500 to 100
	Harvester	P	F	G F	G F	500 to 50
	Small research planting	P	G F	G F	G F	500 to 10
	High-risk yard sale	G				375
	Wholesale nursery		A	A	A	375 to 75
	Exotic retail nursery	A	A		A	250 to 12.5
	Small commercial orchard	P	P	F	F	200 to 10
	Processor of fruit grown in zone	P	F	G F	F	160 to 16
	General retail nursery	A			A	125 to 12.5
	Moderate-risk resident	G				100
	Yard maintenance doing sites in zone	A				100
	Abandoned orchard	F	G	G	G	100 to 10
	Low-exposure packinghouse	G				80
	High-exposure packinghouse	F	G			80 to 40
	Low-exposure distributor	A				60
	High-exposure foodbank	A				50
	High-risk hauler of fruit grown in zone		P			40
	Moderate-risk yard sale	F	G		G	37.5 to 18.8
	Moderate-risk resident	F				10
	Nonresidential landscape fruit trees rated 10-799 in any zone					10 to 799
	Green waste recycler outside of quarantine area					Subjectively rated moderate
	Landfill near fruit production, located outside of quarantine area but receives refuse from quarantine area					Subjectively rated moderate
	Receiver outside of quarantine area but receives byproducts from quarantine area					Subjectively rated moderate
Low (9 to < 1)	All other activities not mentioned under nursery group *(general and exotic retail nurseries, general retail stores selling nursery stock)*, orchard group (*abandoned and small commercial orchards, research plantings*), nonresidential landscape fruit trees, residential, retail fruit group (*supermarkets — all, convenience stores* — all, *small groceries — all, farmer's market and fruit stands, yard sales, mobile vendors* selling in any part of quarantine area, *pushcart vendors, roadside sales* — all), wholesale fruit handlers (*packinghouses, distributors, foodbanks, high-risk hauler, and processors, harvesters*), waste disposal sites (*landfills* outside of quarantine area and not near fruit production, and *green waste recyclers* inside quarantine area), and yard maintenance.					

* **Host preference in the specified zone: A** any host—the activity handles fruits in predominantly one host preference category, so one host preference value was used to calculate risk, and the resulting risk value concerns any host. **G** good, **F** fair, or **P** poor—risk was calculated applying the three host preference values to each scenario.

Conclusions

Not surprisingly for both bull's-eye and areawide programs, before mitigating measures are in place, the highest-risk establishments are commercial orchards. Other establishments with extremely high risk estimates include research plantings, wholesale nurseries, and certain types of haulers and processors. Because their frequency or number in either program is relatively low, all of these establishments can generally be closely regulated quickly at the start of a program.

Concerning the risk from retail fruit handlers, only certain yard sales and mobile vendors pose any significant risk. Other retail fruit handlers such as supermarkets, small groceries, fruitstands, and pushcart vendors pose little risk.

Residential risk results become significant when the number of residents is compared to numbers for other regulatory establishments. Residents within the core with good hosts have a relative risk value of 500 in the bull's-eye program (high end of moderate risk range) and 100 for the areawide program (middle of moderate risk range).

As stated in the introduction, results of this assessment will allow risk managers to develop regulatory guidelines to best limit the risk of additional outbreaks occurring during a Medfly eradication program.

Appendices: The Evidence

E1. Medfly Adult Trapping in Selected Outbreak Areas, 1987–1993

Outbreak		1st-day capture		Succeeding captures by program zone											
				Core		1st buffer		2d buffer		3d buffer		4th buffer		Outer area	
Area	Trap type	Traps/ mi^2	Total flies	Traps/ mi^2	Total flies	Traps/ mi^2	Total flies	Traps/ mi^2	Total flies	Traps/ mi^2	Total flies	Traps/ mi^2	Total flies	Traps/ mi^2	Total flies
California:															
Los Angeles,	J	5	1	100	22	50	7	25	0	20	0	10	1	5	1
1987	M	5	0	25	8	5	1	5	0	5	2	5	0	5	0
West	J	5	1	100	15	50	5	25	4	20	0	10	0	5	0
Los Angeles,	M	5	0	50	9	5	0	5	0	5	0	5	0	5	0
1988	U			?	14										
Northridge,	J	5	2	100	2	50	0	25	2	20	0	10	0	5	0
L.A., 1988	M	5	0	50	0	5	0	5	0	5	0	5	0	5	0
Mountain	J	5	1	100	19	50	0	25	0	20	0	10	0	5	0
View,	M	5	0	25	3	5	0	5	0	5	0	5	0	5	0
1989	S			?	2										
Country	P	0	0	1000	19	0	1	0	0	0	0	0	0	0	0
Club Park,	J	10	0	100	1	50	1+1?	25	0	25	0	10	0	10	2
1991	M	10	1	100	1	10	0	10	0	10	0	10	0	10	0
Oceanside,	P	0	0	1000	1	50	0	0	0	0	0	0	0	0	0
1992	J	10	1	0	0	0	0	25	0	25	0	10	0	10	0
	M	5	0	110	0	5	0	5	0	5	0	5	0	5	0
San Jose,	P	0	0	1000	103	0	0	0	0	0	0	0	0	0	0
1992	J	10	1	50	16	50	0	25	0	20	0	10	0	10	0
	M	5	5	25	3	5	0	5	0	5	0	5	0	5	0
Granada	P	20	0	1000	46	50	8	20	0	20	0	20	5	20	0
Hills,*	J	10	0	0	0	0	1	10	2	10	0	10	0	10	0
1993	M	5	1	25	0	5	0?	5	1	5	1	5	0	5	0
Florida:															
Miami,	J	5	4	100	6	50	1	25	0	20	0	10	0	5	0
1984	M	0?	0	13	0	13	0	0?	0	0?	0	0?	0	0?	0
Miami Springs,	J	5	1	100	14	50	6	25	0	20	0	10	0	5	0
1990	M	5	0	5	2	5	0	5	0	5	0	5	0	5	0

* Includes nearby Chatsworth, Mission Hills, and Pacoima.
Trap code: J = Jackson, M = McPhail, P = Panel, S = Steiner, U = Unknown. Trapping array was estimated by Mike Stefan, DEO, PPQ, from various reports. Adult catches summarized from Medfly Finds database.

E2. Mediterranean Fruit Fly Hosts Regulated by CFR

Scientific name	Common name	Regulated in	
		CA	FL
Actinidia chinensis	Kiwi	C	F
Annona cherimola	Cherimoya	-	F
Annona glabra	Pond apple	-	F
Annona muricata	Soursop	-	F
Annona reticulata	Custard apple	-	F
Annona squamosa	Sugar apple	-	F
Arenga pinnata	Sugar palm	-	F
Argania spinosa	Argan tree	-	F
Blighia sapida	Akee	-	F
Capsicum frutescens, C. annuum	Pepper	C	F
Carica papaya	Papaya	C	F
Carica quercifolia	Dwarf papaya	-	F
Carissa macrocarpa	Natal plum	C	
Casimiroa edulis	White sapote	C	F
Chrysophyllum cainito	Star apple	-	F
Citrus aurantiifolia	Lime, sweet	C	-
Citrus aurantium	Sour orange	C	F
Citrus limetioides	Lima, sweet	-	F
Citrus limon	Lemon except cv. Eureka, Lisbon, Villa Franca in FL, except smooth skinned, cleaned & waxed in CA	C	F
Citrus madurensis	Calamondin orange	C	
Citrus maxima	Pummelo	C	F
Citrus medica	Citron	C	F
Citrus nobilis	Orange, king	C	F
Citrus paradisi	Grapefruit	C	
Citrus reticulata	Mandarin orange, tangerine	C	F
Citrus sinensis	Orange, sweet	C	F
Citrus unshiu	Satsuma, Unshu orange	C	F
Coffea arabica	Coffee	-	F
Crataegus spp.	Hawthorne	-	F
Cydonia oblonga	Quince	C	F
Cyphomandra betacea	Tree tomato	-	F
Diospyros kaki	Japanese persimmon	C	F
Dovyalis caffra	Kei apple	-	F
Dovyalis hebecarpa	Ceylon gooseberry	-	F
Eriobotrya japonica	Loquat	C	F
Eugenia dombeyi	Spanish cherry (Brazilian plum)	C	F
Eugenia uniflora	Surinam cherry	C	F
Euphoria longan	Longan	-	F

E2. Mediterranean Fruit Fly Hosts Regulated by CFR—Continued

Scientific name	Common name	Regulated in	
		CA	FL
Feijoa sellowiana	Pineapple guava	C	F
Ficus carica	Fig	C	F
Fortunella japonica	Kumquat	C	F
Fortunella japonica	Orange, Chinese		F
Garcinia xanthochymus	Gourka	-	F
Geoffroea decorticans	Chanar	-	F
Juglans spp.	Walnut with husk	C	F
Litchi chinensis	Lychee nut	-	F
Lycopersicon esculentum	Tomato (Sweet and red ripe)	C	F
Malpighia glabra	Barbados cherry	-	F
Malus sylvestris	Apple	C	F
Mangifera indica	Mango	C	F
Manilkara zapota	Sapodilla	-	F
Mimusops elengi	Spanish cherry Medlar	-	F
Murraya paniculata	Mock orange	C	F
Ochrosia elliptica	Bourbon orange	-	F
Olea europaea	Olive	C	F
Opuntia spp.	Opuntia cactus	C	F
Passiflora edulis	Passionfruit, yellow lilikoi	-	F
Persea americana	Avocado	C	F
Phoenix dactylifera	Date	C	F
Pouteria campechiana	Canistel	-	F
Pouteria sapota	Mammee, sapote	-	F
Prunus americana	Plum	C	F
Prunus americana x P. salicina	Golden plum	-	F
Prunus armeniaca	Apricot	C	F
Prunus avium, P. cerasus	Cherries, sweet & sour	C	F
Prunus domestica	Prune	C	F
Prunus dulcis	Almond with husk	C	F
Prunus persica	Peach	C	F
Prunus persica var. nucipersica	Nectarine	C	F
Prunus salicina	Japanese plum	C	F
Psidium cattleianum	Cattley guava	-	F
Psidium cattleianum	Strawberry guava		F
P. cattleianum var. cattleianum		C	
Psidium guajava	Guava	C	F
Psidium guajava Pomiform	Pomiform guajava	-	F
Psidium guajava Pyriform	Pyriform guajava	-	F
Punica granatum	Pomegranate	C	F
Pyrus communis	Pear	C	F
Spondias spp.	Mombin	-	F

E2. Mediterranean Fruit Fly Hosts Regulated by CFR—Continued

Scientific name	Common name	Regulated in	
		CA	FL
Spondias mombin	Hog plum, Spanish plum	-	F
Spondias purpurea	Jocote, red mombin	-	F
Syzygium jambos	Rose apple	C	F
Syzygium malaccense	Mountain apple	C	F
Terminalia catappa	Tropical almond	-	F
Terminalia chebula	Myrobalan nut in FL; black myrobalan in CA	C	F
Thevetia peruviana	Yellow oleander (Bestill in CA)	C	F
Vitis spp.	Grape	C	F

E3a. Mediterranean Fruit Fly Larval Properties in southern California by Host, 1975-93

Host	1975	1980	1981	1982	1987	1988	1989	1990	1992	1993	All
Apple										1	1
Apricot											0
Avocado											0
California-laurel											0
Calamondin orange							1	1			2
Cherry											0
Fig							1				1
Grapefruit						2				3	5
Guava			1				1		1	1	4
Guava, Mexican									1		1
Guava, Pineapple											0
Guava, Strawberry							1				1
Indian peach											0
Kumquat						1	1	2			4
Lemon,* Meyer			1				2			1	4
Loquat		1									1
Mandarin orange											0
Orange						4	7		1		12
Orange, Sour										1	1
Nectarine										4	4
Peach	12		3		1		8		5	20	49
Pear											0
Persimmon						1	3				4
Plum										1	1
Quince											0
Rangpur lime											0
Sweet pepper											0
Tangelo											0
Tangerine										1	1
Walnut											0
Unspecified			2								2
Total	12	1	7	0	1	8	25	3	8	33	98

* Host specified as Meyer lemon for 1981 host property; other properties identified only as lemon.
Source: Mike Stefan 12/93 and USDA - California Cooperative Medfly Eradication Project Chronology.

E3b. Mediterranean Fruit Fly Larval Properties: Monthly Finds in southern California by Host, 1975-93

Host	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	?	All
Apple								1						1
Apricot														0
Avocado														0
California-laurel														0
Calamondin orange	1											1		2
Cherry														0
Fig										1				1
Grapefruit									2	3				5
Guava								1	2	1				4
Guava, Mexican										1				1
Guava, Pineapple														0
Guava, Strawberry									1					1
Indian peach														0
Kumquat		2								2				4
Lemon,* Meyer										4				4
Loquat						1								1
Mandarin orange														0
Orange										10	2			12
Orange, Sour										1				1
Nectarine							4							4
Peach							3	19	9	6			12	49
Pear														0
Persimmon										4				4
Plum							1							1
Quince														0
Rangpur lime														0
Sweet pepper														0
Tangelo														0
Tangerine										1				1
Walnut														0
Unspecified								1					1	2
Total	3	0	0	0	0	1	8	22	14	34	2	1	13	98

* Host specified as Meyer lemon for 1981 host property; other properties identified only as lemon.
Source: Mike Stefan 12/93 and USDA - California Cooperative Medfly Eradication Project Chronology.

E4a. Mediterranean Fruit Fly Larval Properties in northern California by Host, 1975-93

Host	1975	1980	1981	1982	1987	1988	1989	1990	1992	1993	All
Apple		11									11
Apricot		24	146								170
Avocado		1									1
California-laurel		1									1
Calamondin orange		1									1
Cherry			1								1
Fig		4	2								6
Grapefruit		1	1								2
Guava		2									2
Guava, Mexican											0
Guava, Pineapple		3									3
Guava, Strawberry		2	1								3
Indian peach		1									1
Kumquat		3									3
Lemon,* Meyer		8	1								9
Loquat	1	3	1								5
Mandarin orange			1								1
Orange		28									28
Orange, Sour											0
Nectarine		12	5						3		20
Peach	1	55	21				2		18		97
Pear		4	1								5
Persimmon		12									12
Plum		1	3								4
Quince		1									1
Rangpur lime		1									1
Sweet pepper		1									1
Tangelo		1									1
Tangerine			1								1
Walnut		2									2
Unspecified		1	2								3
Total	2	184	187	0	0	0	2	0	21	0	396

* Host specified as Meyer lemon for 1981 host property; other properties identified only as lemon.
Source: Mike Stefan 12/93 and USDA - California Cooperative Medfly Eradication Project Chronology.

E4b. Mediterranean Fruit Fly Larval Properties: Monthly Finds in northern California by Host, 1975-93

Host	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	?	All
Apple									2	6	2	1		11
Apricot						51	117	2						170
Avocado											1			1
California-laurel												1		1
Calamondin orange												1		1
Cherry							1							1
Fig						1	1		1	3				6
Grapefruit						1				1				2
Guava											2			2
Guava, Mexican														0
Guava, Pineapple										2	1			3
Guava, Strawberry	1											2		3
Indian peach									1					1
Kumquat										1	1	1		3
Lemon,* Meyer							2		1	4		2		9
Loquat						1	1	3						5
Mandarin orange								1						1
Orange							1	4	4	8	10	1		28
Orange, Sour														0
Nectarine						3	7	10						20
Peach						4	21	57	11	3	1			97
Pear										3	2			5
Persimmon										1	5	6		12
Plum						1	3							4
Quince										1				1
Rangpur lime								1						1
Sweet pepper											1			1
Tangelo												1		1
Tangerine						1								1
Walnut								1		1				2
Unspecified							1	1					1	3
Total	1	0	0	0	0	63	155	80	20	34	26	16	1	396

* Host specified as Meyer lemon for 1981 host property; other properties identified only as lemon.
Source: Mike Stefan 12/93 and USDA - California Cooperative Medfly Eradication Project Chronology.

E5a. Mediterranean Fruit Fly Larval Properties in Florida by Host, 1929-87

Host	1929	1956	1963	1984	1987
Calamondin			X†		1*
Grapefruit	X*	X*			
Orange cvs., early			X†		
Persimmon			X†		
Sour orange				1*	
Tangerine			X†		

X denotes unknown number of larval properties.

*Clark and Weems 1989.

†Microfilmed records for Florida located in the APHIS Information Center, Riverdale, MD, reported as heavy infestations or high populations, insect stage unspecified.

E5b. Mediterranean Fruit Fly Larval Properties: Monthly Finds in Florida by Host, 1929-87

Host	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Calamondin	X†		X*									
Grapefruit				X*								
Orange cvs., early		X†										
Persimmon		X†										
Sour orange						X*						
Tangerine		X†										

X denotes unknown number of larval properties.

*Clark and Weems 1989.

†Microfilmed records for Florida located in the APHIS Information Center, Riverdale, MD, reported as heavy infestations or high populations, insect stage unspecified.

E6. Mediterranean Fruit Fly Larval Properties in Texas by Host, 1966

Host	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Calamondin						1							1
Peach						9	4						13
Sour Orange						1							1
Total						11	4						15

Source: Microfilmed identification records for Texas located in the APHIS Information Center, Riverdale, MD.

E7. Los Angeles Host Count from Medfly Regulatory Activities. Not all are necessarily Medfly hosts We will use the list to show the presence of Medfly hosts and their relative numbers in the area.

Almond	163	Eugenia	19	Ornamental holly	1
Apple	4573	Evergreen pear	2	Ornamental pear	1
Apricot	8012	Ficus	7	Ornamental plum	1
Asian pear	1	Fig	7032	Palm	1
Avocado	8280	Flowering peach	1	Papaya	40
Banana	681	Flowering plum	67	Passion fruit	76
Bean	2	Fruit	1	Peach	14976
Bell pepper	9	Grape	906	Pear	501
Berry	45	Grapefruit	4704	Pecan	20
Berry tree	1	Guava	3182	Pepper	63
Black walnut	4	Hollyberry	3	Pepper squash	1
Blackberry	16	Jacaranda	2	Pepper tree	9
Blueberry	3	Japanese pear	1	Persimmon	1671
Boysenberry	18	Jerusalem cherry	1	Philodendron	40
Brazilian pepper	31	Jujube	5	Pine	2
Cabbage	1	Kiwi	18	Pineapple	128
Cactus pear	214	Kumquat	1175	Pineapple guava	472
Calamondin	149	Lemon	21342	Plum	6746
Cantaloupe	1	Lime	972	Pomegranate	1259
Carob	2	Liquidambar	1	Pomelo	24
Carrot wood	6	Loquat	4825	Pumpkin	6
Catalina cherry	5	Macadamia	23	Quince	193
Ceriman	60	Magnolia	7	Raspberry	28
Chayote	49	Mandarin orange	29	Rubber tree	1
Cherimoya	37	Mango	339	Sapote	431
Cherry	181	Maple	7	Sewello	5
Cherry tomato	2	Melon	13	Squash	49
Chestnut	1	Mexican guava	856	Stone fruit	76
Chili pepper	22	Mexican lemon	2	Strawberry	182
Chilote	1	Mexican lime	3	Strawberry guava	56
Chinese grapefruit	1	Mexican orange	1	Sugarcane	14
Chinese magnolia	1	Mulberry	47	Sycamore	3
Citron	2	Natal plum	41	Tangelo	266
Citrus	1263	Nectarine	2772	Tangerine	3541
Coffee	1	Nut	3	Tomato	833
Corn	8	Oak	1	Vegetables	1
Crabapple	4	Oleander	1	Vine	1
Cucumber	5	Olive	1577	Walnut	535
Cypress	1	Onion	3	Watermelon	3
Date	9	Orange	19991	Willow	2
Eggplant	6	Ornamental	1103		
Elm tree	1	Ornamental banana	1	Total	127219
Eucalyptus	2	Ornamental guava	1		

Source: CDFA Host Inventory database, data entered in Oct-Nov 1990.

E8a. Interception Frequency of Medfly by Host, CY 1971–87

Host	No. of interceptions*
Capsicum spp.†	189
Citrus spp.	115
Coffea arabica	285
Cydonia oblonga	43
Diospyros spp.	14
Eriobotrya japonica	20
Ficus carica	234
Malus sylvestris	32
Mangifera indica	70
Opuntia spp.	35
Passiflora spp.	13
Prunus armeniaca	14
Prunus persica	74
Psidium guajava	174
Punica granatum	24
Pyrus communis	34
Syzygium spp.	21
Terminalia catappa	94
Vitis spp.	10
All others	167
Total	1662

*All hosts listed are for 10 or more interceptions.

†The 189 interceptions from *Capsicum* from West Africa were identified as *Ceratitis* sp. or *Ceratitis capitata*.
Source: Miller, et al. 1992: 88

E8b. Mediterranean Fruit Fly Interceptions on Regulated and Nonregulated Hosts, CY 1988–92

Host scientific name	No. of interceptions	Regulated in*	
		CA	FL
Actinidia chinensis	0	C	F
Annona sp.†	1	–	–
Annona cherimola	0	–	F
Annona glabra	0	–	F
Annona muricata	0	–	F
Annona reticulata	0	–	F
Annona squamosa	1	–	F
Arenga pinnata	0	–	F
Argania spinosa	0	–	F
Blighia sapida	0	–	F
Cactaceae†	4	–	–
Capsicum spp.†	19	–	–
Capsicum frutescens, C. annuum	0	C	F
Carica papaya	1	C	F
Carica quercifolia	0	–	F
Carissa macrocarpa	0	C	F
Casimiroa edulis	0	C	F
Chrysophyllum cainito	0	–	F
Citrus spp.	18	–	–
Citrus aurantiifolia	0	C	–
Citrus aurantium	0	C	F
Citrus limettioides	0	–	F
Citrus limon	2	C	F
Citrus madurensis	0	C	F
Citrus maxima	0	C	F
Citrus medica	0	C	F
Citrus nobilis	0	C	F
Citrus paradisi	1	C	F
Citrus reticulata	10	C	F
Citrus sinensis	10	C	F
Citrus unshiu	0	C	F
Coffea sp.†	1	–	–
Coffea arabica	23	–	F
Crataegus spp.	0	–	F
Cydonia spp.†	2	–	–
Cydonia oblonga	6	C	F
Cyphomandra betacea	0	–	F
Diospyros spp.†	6	–	–
Diospyros kaki	0	C	F
Diospyros virginiana†	1	–	–

E8b. Mediterranean Fruit Fly Interceptions on Regulated and Nonregulated Hosts, CY 1988–92—Continued

Host scientific name	No. of interceptions	Regulated in*	
		CA	FL
Dovyalis caffra	0	–	F
Dovyalis hebecarpa	0	–	F
Eriobotrya sp.†	1	–	–
Eriobotrya japonica	6	C	F
Eriocephalus sp.†	1	–	–
Eugenia sp.†	1	–	–
Eugenia dombeyi	0	C	F
Eugenia uniflora	0	C	F
Euphoria longan	0	–	F
Feijoa spp.†	2	–	–
Feijoa sellowiana	0	C	F
Ficus spp.†	52	–	–
Ficus carica	128	C	F
Ficus citrifolia†	1	–	–
Fortunella spp.†	3	–	–
Fortunella japonica	0	C	F
Garcinia xanthochymus	0	–	F
Geoffroea decorticans	0	–	F
Juglans spp.	0	C	F
Litchi chinensis	0	–	F
Lycopersicon esculentum	0	C	F
Malpighia glabra	0	–	F
Malus spp.†	4	–	–
Malus angustifolia†	1	–	–
Malus sylvestris	7	C	F
Mammea americana†	1	–	–
Mangifera indica	12	C	F
Manilkara zapota	0	–	F
Mespilus germanica†	1	–	–
Mimusops elengi	0	–	F
Murraya paniculata	0	C	F
Ochrosia elliptica	0	–	F
Olea spp.†	4	–	–
Olea europaea	16	C	F
Onagraceae†	1	–	
Opuntia spp.	6	C	F
Passiflora edulis	0	–	F
Persea americana	2	C	F
Phoenix dactylifera	3	C	F
Pouteria campechiana	0	–	F

E8b. Mediterranean Fruit Fly Interceptions on Regulated and Nonregulated Hosts, CY 1988–92—Continued

Host scientific name	No. of interceptions	Regulated in*	
		CA	FL
Pouteria sapota	1	–	F
Prunus spp.†	12	–	–
Prunus americana	0	C	F
Prunus americana x P. salicina	0	–	F
Prunus armeniaca	5	C	F
Prunus avium	1	C	F
Prunus cerasus	0	C	F
Prunus domestica	1	C	F
Prunus dulcis	2	C	F
Prunus persica	17	C	F
Prunus persica var. nucipersica	–	C	F
Prunus salicina	0	C	F
Psidium spp.†	14	–	–
Psidium cattleianum	1	–	F
		C	F
Psidium guajava	58	C	F
Psidium guajava Pomiform	–	–	F
Psidium guajava Pyriform		–	F
Punica granatum	11	C	F
Pyrus spp.†	4	–	–
Pyrus communis	3	C	F
Spondias spp.	0	–	F
Spondias mombin	0	–	F
Spondias purpurea	0	–	F
Syzygium jambos	0	C	F
Syzygium malaccense	0	C	F
Terminalia catappa	4	–	F
Terminalia chebula	0		
Thevetia peruviana	0	C	F
Vitis spp.	3	C	F
Vitis labrusca	1	C	F
Total	501		

*Host is regulated by Title 7, Part 301 of the Code of Federal Regulations.

†Host (or the listed name is not stated as such in the CFR) is not regulated by Title 7, Part 301 of the Code of Federal Regulations.

Interception source: PINET and PPQ 309 Databases, CY 1988-92.

E9. Fruit Weight and Adult Emergence of Mediterranean Fruit Fly by Host, Guatemala and Mexico

Host Scientific name	Fruit/kg	Samples	Guatemala (E)		Mexico (S)	
			Pupae/kg of fruit	Samples	Larvae/kg of fruit	Samples
*Anacardium occidentale**	10.0	16 (E)	0.1	16		
*Byrsonima crassifolia**	302.7	16 (E)	0.5	16		
Carica papaya	2.3	13 (R)	0.8	23		
	0.8	23 (E)				
Casimiroa edulis	10.0	2 (E)	8.4	2		
Chrysophyllum cainito	15.0	15 (R)			0.0093	1,994
	14.0	1,994 (S)				
Citrus aurantiifolia	11.7	40 (E)	0.3	40		
Citrus aurantium	5.7	99 (E)	2.8	99	0.0006	5,872
	5.8	273 (R)				
	5.3	5,872 (S)				
*Citrus deliciosa**	12.4	53 (E)	1.1	53		
	5.1	10 (R)				
*Citrus limetta**	8.7	58 (E)	0.1	58		
	7.3	14 (R)				
Citrus madurensis	48.2	3 (E)	0	3		
Citrus maxima	1.8	4 (E)	0	4	0.0002	2,305
	3.1	166 (R)				
	2.4	2,305 (S)				
Citrus paradisi	2.9	28 (E)	2.1	28		
	1.6	33 (R)				
Citrus reticulata	25.1	114 (R)			0.0091	4,256
		4,256 (S)				
Citrus sinensis	6.2	178 (E)	0.3	178	0.0010	7,190
	5.9	464 (R)				
	5.6	7,190 (S)				
'Valencia '	6.4	62 (E)	0.3	62		
'Washington'	9.2	53 (E)	0.8	53		
Coffea arabica	641.3	267 (E)	8.4	267	0.2847	13,160
	696.3	13,160 (S)				
Eriobotrya japonica	77.8	30 (E)	1.0	30		
Eugenia uniflora	967.5	4 (E)	0	4		
*Inga micheliana**	40.6	2 (E)	0	2		
	8.8	17 (R)				
*Malus pumila**	17.0	24 (E)	0.2	24		
Manilkara zapota	9.9	157 (S)				
Mangifera indica	4.8	24 (E)	0.1	24		
	1.0	77 (R)				
*Micropholis** sp.	42.0	27 (R)				
	58.8	32 (S)				

E9. Fruit Weight and Adult Emergence of Mediterranean Fruit Fly by Host, Guatemala and Mexico—Continued

Host Scientific name	Fruit/kg	Samples	Guatemala (E)		Mexico (S)	
			Pupae/kg of fruit	Samples	Larvae/kg of fruit	Samples
*Parmentiera aculeata**	15.8	13 (E)	0	13		
*Pouteria viridis**	5.6	8 (E)	1.7	8		
Prunus domestica	24.8	16 (E)				
plum, red	17.1	1 (E)	0.2	1		
plum, yellow	35.0	1 (E)	red & yellow	1		
Prunus persica						
'Cling'	9.6	9 (E)	0.9	9		
'Freestone'	15.8	9 (E)	8.7	9		
Psidium cattleianum	126.8	17 (E)	25.4	17		
Psidium guajava	11.2	34 (E)	2.6	34	0.1400	3,947
	14.4	169 (R)				
	19.0	3,947 (S)				
Punica granatum	6.5	4 (E)	0.7	4		
Pyrus communis	7.8	3 (E)	6.1	3		
'Catman'	6.1	24 (E)	0.5	24		
'Keifer'	6.3	15 (E)	1.5	15		
Spondias purpurea	97.2	8 (E)	0.2	8		
Syzygium jambos	38.3	3 (E)	0.4	3	0.0170	119
	65.2	5 (R)				
	47.5	119 (S)				

*Host is not regulated by Title 7, part 301 of the Code of Federal Regulations.
E: Eskafi, Kolbe 1990:1376 Guatemala pupae.
R: de la Rosa et al. 1985
S: SARH 1983

E10. Fruit Weight and Adult Emergence of Mediterranean Fruit Fly by Host, Hawaii

Host scientific name	Fruit		Number of adults emerged per kilogram of fruit									
			Hawaii State (N)		Hawaii Island (L)		Kauai (V)		Maui (W)		Oahu (H)	
	No./kg	Samples	Adult range	Fruit samples	Adults*	Fruit samples	Adults	Fruit samples	Adults	Fruit samples	Adults	Fruit samples
Annona cherimola					8.9	14						
Annona muricata			≤ 9	12								
Annona reticulata x					2.6	3						
Artocarpus altilis					0.9	52						
Blighia sapida					2.2	9						
Calophyllum inophyllum					1.8	67						
Capparis sandwichiana					40.8	7						
Capsicum annuum var. *annuum* Grossum Group					39.0	9						
Carica papaya	2.3 0.8	13 (R) 323 (E)			165.6	384						
Casimiroa edulis	10.0	2 (E)			5.4	9						
Citrus spp. orange	8.7	27 (W)							1.4 0.2 8.4	8 8 11		
Citrus aurantiifolia	11.7	40 (E)			0.6	31						
Citrus limon					0.8	72						
Citrus madurensis	48.2	3 (E)			70.0	17						
Citrus maxima	1.8 3.1 2.4	4 (E) 166 (R) 2,305 (S)			4.1	17						
Citrus x *paradisi*	2.9 1.6	28 (E) 33 (R)			3.9	56						
Citrus reticulata	23.3	114 (R) 4,256 (S)			3.7	182					0	1
Citrus sinensis	6.2 5.9 5.6 6.7 3.7	178 (E) 464 (R) 5,872 (S) 10 (V)	51-99	40			0.1 0.1	5 5				

E10. Fruit Weight and Adult Emergence of Mediterranean Fruit Fly by Host, Hawaii—Continued

Host scientific name	Fruit		Number of adults emerged per kilogram of fruit									
			Hawaii State (N)		Hawaii Island (L)		Kauai (V)		Maui (W)		Oahu (H)	
	No./kg	Samples	Adult range	Fruit samples	Adults*	Fruit samples	Adults	Fruit samples	Adults	Fruit samples	Adults	Fruit samples
C. sinensis 'Valencia'	6.4	2 (E)									0	1
'Washington'	9.2	53 (E)				479						
'Navel' and 'Valencia'					2.2							
Citrus x *tangelo*					4.4	9						
Clausena lansium					4.2	2						
Coffea arabica	641.3	267 (E)	100-199	86	176.3	1,517	2.4	4			124.6	428
	690.7	428 (H)					6.8	5				
	696.3	13,160 (S)										
	568.2	9 (V)										
	644.2											
Cyphomandra betacea					8.1	12						
Diospyros kaki	10.0	12 (W)	10-50	12	17.2	5			3.3	4		
									3.7	5		
									10.6	3		
Eriobotrya japonica	77.8	30 (E)	100-199	42	20.0	263	2.7	2	32.9	12		
	76.7	2 (V)							31.9	8		
	67.1	30 (W)							57.6	10		
Eugenia uniflora	967.5	4 (E)	100-199	4	8.1	82						
Euphoria longan					6.3	25						
Ficus carica	34.2	22 (W)	≥ 200	28	18.6	20			63.8	7		
									67.9	8		
									61.0	7		
Fortunella japonica					178.4	32						
Juglans nigra					117.6	3						
Juglans regia					366.6	77						
Lycopersicon esculentum					22.5	266						
Malpighia punicifolia					13.1	70						
Malus sylvestris					79.0	63						
Mangifera	4.8	24 (E)	≤ 9	16	3.7	626	0.1	5			2.4	11
	6.7	11 (H)					0.1	7				

E10. Fruit Weight and Adult Emergence of Mediterranean Fruit Fly by Host, Hawaii—Continued

Host scientific name	Fruit		Number of adults emerged per kilogram of fruit									
			Hawaii State (N)		Hawaii Island (L)		Kauai (V)		Maui (W)		Oahu (H)	
	No./kg	Samples	Adult range	Fruit samples	Adults*	Fruit samples	Adults	Fruit samples	Adults	Fruit samples	Adults	Fruit samples
Mangifera—Continued	1.0	77 (R)										
	5.3	12 (V)										
	5.5											
Momordica charantia					13.8	394						
Murraya paniculata	1,803.0	10 (H)	100-199	10	45.3	12					2.4	10
Musa x *paradisiaca*					1.4	10						
Opuntia ficus-indica					1.8	63						
Passiflora ligularis					1.8	3						
Persea americana					3.2	101						
Phyllanthus acidus					2.9	2						
Physalis peruviana					11.0	5						
Pouteria viridis	5.6	8 (E)			10.2	6						
Prunus armeniaca					340.6	63						
Prunus domestica	24.8	16 (E)	≤ 9 spp.	18	50.5	355			0.5	4		
	25.7	18 (W)							8.3	8		
									0.3	6		
Prunus persica	9.6	9 (E)	≥ 200	44	203.6	291	6.0	8	101.5	7		
	38.1	8 (V)							199.2	12		
	34.5	35 (W)							78.1	8		
									62.1	8		
Prunus salicina x *P. cerasifera*					69.4	4						
Psidium cattleianum	126.8	17 (E)	10-50	35			0.2	14				
	189.8	35 (V)					0.3	12				
	152.3						0.1	9				
	121.2											
strawberry guava, purple					21.2	118						
strawberry guava, yellow					12.1	24						

E10. Fruit Weight and Adult Emergence of Mediterranean Fruit Fly by Host, Hawaii—Continued

Host scientific name	Fruit		Number of adults emerged per kilogram of fruit									
			Hawaii State (N)		Hawaii Island (L)		Kauai (V)		Maui (W)		Oahu (H)	
	No./kg	Samples	Adult range	Fruit samples	Adults*	Fruit samples	Adults	Fruit samples	Adults	Fruit samples	Adults	Fruit samples
Psidium guajava	11.2	34 (E)	≤ 9	40	9.7	2,765	0.2	5	6.9	9	12.3	6
	9.7	6 (H)							7.4	8		
	14.4	169 (R)							4.3	12		
	19.0	3,947 (S)										
	12.9	5 (V)										
	27.8	29 (W)										
Pyrus communis	7.8	3 (E)			1.1	3						
Rubus lucidus					11.9	5						
Santalum spp.	734.8	6 (V)	≤ 9	6	11.1	2	2.2	6				
Solanum melongena					353.6	24			14			
Solanum muricatum					8.0	8						
Solanum pseudocapsicum			51-99	10	664.3	2,429						
Solanum seaforthianum					0.2	5						
Spondias cytherea					5.3	64						
Syzygium cumini					17.9	11						
Syzygium jambos	38.3	3 (E)			27.2	317						
	65.2	5 (R)										
	47.5	119 (S)										
Syzygium malaccense	19.1	5 (R)			1.4	80						
Terminalia catappa	74.6	15 (H)	≤ 9	20	1.3	313					10.3	15
Wikstroemia phillyreifolia					19.8	37						

* Adult emergence per kilogram of infested fruit in survey between 1949 and 1985.
(E): Eskafi & Kolbe 1990
(H): Harris and Lee 1986
(L): Liquido et al. 1990
(N): Nishida et al. 1985
(R): de la Rosa et al. 1985
(S): SARH 1983
(V): Vargas et al. 1983 - Separate numbers indicate separate locations
(W): Wong et al. 1983 - Separate numbers indicate separate years

Plant Lists

Most of the plant names used in this document are cross-referenced in the following two lists. Some are not Medfly hosts.

E11a. Plant List: Scientific Name to Common Name

Scientific name*	Common name†
Achras zapota = *Manilkara zapota*	
Actinidia chinensis	Kiwi
Anacardium occidentale	Cashew
Annona cherimola	Cherimoya
Annona glabra	Pond-apple
Annona muricata	Soursop
Annona reticulata	Custard-apple
Annona squamosa	Sugar-apple
Arenga pinnata	Sugar palm
Argania sideroxylon = *Argania spinosa*	
Argania spinosa	Argan tree
Artocarpus altilis	Breadfruit
Blighia sapida	Akee
Byrsonima crassifolia	Craboo; nance
Cactaceae†	Cactus family
Calocarpum sapota = *Pouteria sapota*	
Calocarpum viride = *Pouteria viridis*	
Calophyllum inophyllum	Kamani
Capparis sandwichiana	Puapilo
Capsicum annuum var. *annuum*	Bell pepper
Capsicum frutescens, *C. annuum*	Pepper
Carica cauliflora	Papaya silvestre
Carica papaya	Papaya
Carica quercifolia	Dwarf papaya
Carissa grandiflora = *Carissa macrocarpa*	
Carissa macrocarpa	Natal plum
Casimiroa edulis	White sapote; sapote cvs.
Ceratonia siliqua	Carob
Chrysophyllum cainito	Caimito; star-apple
Citrofortunella mitis = *Citrus madurensis*	
Citrus spp.	Mandarina china; naranja injerto; orange
Citrus aurantiifolia	Lime; Mexican or Persian lime
Citrus aurantium	Sour orange
Citrus deliciosa	Mediterranean tangerine
Citrus grandis = *Citrus maxima*	
Citrus limetta	Sweet lemon; sweet lime
Citrus limettioides	Sweet lima
Citrus limon	Lemon
Citrus limon x *Citrus sinensis*	Meyer lemon
Citrus limonia	Rangpur lime
Citrus limonum = *Citrus limon*	
Citrus madurensis	Calamondin
Citrus maxima	Pummelo; pomelo; shaddock
Citrus medica	Citron
Citrus mitis = *Citrus madurensis*	
Citrus nobilis	King orange
Citrus paradisi	Grapefruit
Citrus reticulata	Mandarin orange; tangerine
Citrus reticulata var. Unshu = *Citrus unshiu*	
Citrus reticulata x C. sinensis = *Citrus nobilis*	
Citrus sinensis	Sweet orange
Citrus tangelo	Tangelo
Citrus unshiu	Satsuma orange
Clausena lansium	Wampi
Coffea arabica	Coffee
Crataegus spp.	Hawthorns
Cydonia oblonga	Quince
Cyphomandra betacea	Tree tomato
Dimocarpus longan = *Euphoria longan*	
Diospyros kaki	Japanese persimmon
Diospyros virginiana	American persimmon
Dovyalis caffra	Kei apple
Dovyalis hebecarpa	Ceylon gooseberry
Eriobotrya japonica	Loquat
Eriocephalus sp.	An aster
Eugenia brasiliensis = *Eugenia dombeyi*	
Eugenia dombeyi	Spanish cherry (Brazilian plum)
Eugenia jambos = *Syzygium jambos*	
Eugenia malaccensis = *Syzygium malaccense*	
Eugenia uniflora	Surinam cherry
Euphoria longan	Longan
Feijoa sellowiana	Pineapple guava
Ficus carica	Fig
Ficus citrifolia	Moraceous tree, a
Fortunella japonica	Kumquat
Garcinia xanthochymus	Gourka

E11a. Plant List: Scientific Name to Common Name—Continued

Scientific name	Common name
Geoffroea decorticans	Chanar
Harpephyllum caffrum	Kaffir-plum
Inga laurina	Caspirol
Inga micheliana	Cushin; chalum
Inga spuria	Cainicuil
Juglans nigra	Black walnut
Juglans regia	English walnut
Litchi chinensis	Litchi; lychee
Lucuma salicifolia = *Pouteria campechiana*	
Lycopersicon lycopersicum = *Lycopersicon esculentum*	
Lycopersicon esculentum	Tomato
Malpighia glabra	Barbados cherry
Malpighia punicifolia	Acerola
Malus angustifolia	Southern crab apple
Malus domestica	Apple
Malus pumila	Paradise apple
Malus sylvestris	Crab apple, a
Mammea americana	Mammey-apple
Mangifera indica	Mango
Manilkara zapota	Sapodilla
Mespilus germanica	Medlar
Mimusops elengi	Spanish cherry; medlar
Momordica charantia	Bittermelon
Monstera deliciosa	Ceriman; cutleaf philodendron
Murraya exotica = *Murraya paniculata*	
Murraya paniculata	Orange jessamine; mockorange
Musa paradisiaca	Banana
Ochrosia elliptica	Bourbon orange
Olea europaea	Olive
Onagraceae	Evening primrose family
Opuntia ficus-indica	Spineless cactus
Parmentiera aculeata	Cauchilote
Parmentiera edulis = *Parmentiera aculeata*	
Passiflora edulis	Purple granadilla
Passiflora ligularis	Sweet granadilla
Persea americana	Avocado
Phoenix dactylifera	Date
Phyllanthus acidus	Otaheite gooseberry
Physalis peruviana	Poha
Pouteria campechiana	Canistel
Pouteria sapota	Mamey; mammee; sapote
Pouteria viridis	Injerto; Green sapote
Prunus americana	American plum
Prunus americana x *P. salicina*	Golden plum
Prunus amygdalus = *Prunus dulcis*	
Prunus armeniaca	Apricot
Prunus avium	Sweet cherry
Prunus cerasus	Sour cherry
Prunus domestica	Plum
Prunus dulcis	Almond
Prunus ilicifolia	Catalina cherry
Prunus persica	Peach
Prunus persica var. nectarina = *P. persica var. nucipersica*	
Prunus persica var. nucipersica	Nectarine
Prunus salicina	Japanese plum
Prunus salicina x *P. cerasifera*	Methley plum
Psidium cattleianum	Strawberry guava
Psidium cattleianum var. cattleianum	strawberry guava, Purple or red
Psidium cattleianum var. littorale	strawberry guava, Yellow
Psidium guajava	Guava; guayaba; Mexican guava
Psidium littorale = *Psidium cattleianum*	
Punica granatum	Pomegranate
Pyrus communis	Pear
Pyrus pyrifolia	Asian or Japanese pear
Rubus lucidus	Blackberry, a
Santalum spp.	Sandalwood
Solanum melongena	Eggplant
Solanum muricatum	Pepino
Solanum pseudocapsicum	Jerusalem cherry
Solanum seaforthianum	Brazilian nightshade
Spondias cytherea	Wi apple
Spondias mombin	Hog plum; Spanish plum
Spondias purpurea	Purple mombin; Red mombin
Syzygium cumini	Java plum
Syzygium jambos	Rose apple
Syzygium malaccense	Mountain apple
Terminalia catappa	Tropical almond
Terminalia chebula	Myrobalan; black myrobalan
Thevetia peruviana	Yellow oleander; Bestill
Umbellularia californica	California-laurel
Vitis labrusca	Fox grape
Wikstroemia phillyreifolia	Akia

* The majority of scientific names have been checked against a database under the National Genetic Resources Program (See References).
† Semicolons separate multiple common names. A comma in a common name indicates an inverted name.

E11b. Plant List: Common Name to Scientific Name

Common name*	Scientific name†
Acerola	*Malpighia punicifolia*
Akee	*Blighia sapida*
Akia	*Wikstroemia phillyreifolia*
Almond	*Prunus dulcis*
Apple	*Malus domestica*
apple, Paradise	*Malus pumila*
Apricot	*Prunus armeniaca*
Argan tree	*Argania spinosa*
Avocado	*Persea americana*
Banana	*Musa paradisiaca*
Barbados cherry	*Malpighia glabra*
Bittermelon	*Momordica charantia*
Blackberry, a	*Rubus lucidus*
Black myrobalan	*Terminalia chebula*
Bourbon orange	*Ochrosia elliptica*
Brazilian nightshade	*Solanum seaforthianum*
Breadfruit	*Artocarpus altilis*
Cactus family	Cactaceae†
Caimito; star-apple	*Chrysophyllum cainito*
Cainicuil	*Inga spuria*
Calamondin	*Citrus madurensis*
California-laurel	*Umbellularia californica*
Canistel	*Pouteria campechiana*
Carob	*Ceratonia siliqua*
Cashew	*Anacardium occidentale*
Caspirol	*Inga laurina*
Cauchilote	*Parmentiera aculeata*
Catalina cherry	*Prunus ilicifolia*
Ceriman; cutleaf philodendron	Monstera deliciosa
Ceylon gooseberry	*Dovyalis hebecarpa*
Chanar	*Geoffroea decorticans*
Cherimoya	*Annona cherimola*
cherry, Sour	*Prunus cerasus*
cherry, Sweet	*Prunus avium*
Citron	*Citrus medica*
Coffee	*Coffea arabica*
Crab apple, a	*Malus sylvestris*
crabapple, Southern	*Malus angustifolia*
Craboo; nance	*Byrsonima crassifolia*
Cushin; chalum	*Inga micheliana*
Custard-apple	*Annona reticulata*
Date	*Phoenix dactylifera*
Eggplant	*Solanum melongena*
Evening primrose family	Onagraceae
Fig	*Ficus carica*
Gourka	*Garcinia xanthochymus*
grape, Fox	*Vitis labrusca*
Grapefruit	*Citrus paradisi*
Guava; guayaba; Mexican guava	*Psidium guajava*
guava, Pineapple	*Feijoa sellowiana*
guava, Strawberry	*Psidium cattleianum*
Hawthorns	*Crataegus* spp.
Hog plum; Spanish plum	*Spondias mombin*
Green sapote	*Pouteria viridis*
Java plum	*Syzygium cumini*
Jerusalem cherry	*Solanum pseudocapsicum*
Kaffir-plum	*Harpephyllum caffrum*
Kamani	*Calophyllum inophyllum*
Kei apple	*Dovyalis caffra*
Kiwi	*Actinidia chinensis*
Kumquat	*Fortunella japonica*
Lemon	*Citrus limon*
Sweet lemon; sweet lime	*Citrus limetta*
lemon, Meyer	*Citrus limon* x *Citrus sinensis*
lemon, Sweet	*Citrus limetta*
Lima, Sweet	*Citrus limettioides*
Lime: also Mexican or Persian	*Citrus aurantiifolia*
lime, Rangpur	*Citrus limonia*
lime, Sweet	*Citrus limetta*
Limon real	*Citrus limonium*
Litchi; lychee	*Litchi chinensis*
Longan	*Euphoria longan*
Loquat	*Eriobotrya japonica*
Mamey; mammee; sapote	*Pouteria sapota*
Mammey-apple	*Mammea americana*
Mandarina china; naranja injerto; orange	*Citrus* spp.
Mango	*Mangifera indica*
Mediterranean tangerine	*Citrus deliciosa*
Medlar	*Mespilus germanica*
Mockorange	*Murraya paniculata*
Mountain apple	*Syzygium malaccense*
Myrobalan	*Terminalia chebula*
Natal plum	*Carissa macrocarpa*
Nectarine	*Prunus persica var. nucipersica*
Okra	*Abelmoschus esculentus*
Olive	*Olea europaea*
orange, King	*Citrus nobilis*
orange, Mandarin; tangerine	*Citrus reticulata*
orange, Satsuma	*Citrus unshiu*
orange, Sour	*Citrus aurantium*
orange, Sweet	*Citrus sinensis*
Orange jessamine	*Murraya paniculata*
Otaheite gooseberry	*Phyllanthus acidus*
Papaya	*Carica papaya*
papaya, Dwarf	*Carica quercifolia*
Papaya silvestre	*Carica cauliflora*
Peach	*Prunus persica*
Pear	*Pyrus communis*
pear, Asian or Japanese	*Pyrus pyrifolia*
Pepino	*Solanum muricatum*
Pepper	*Capsicum frutescens, C. annuum*

E11b. Plant List: Common Name to Scientific Name—Continued

Common name*	Scientific name†	Common name	Scientific name
pepper, Bell	*Capsicum annuum* var. *annuum*	Sandalwood	*Santalum* spp.
		Sapodilla	*Manilkara zapota*
persimmon, American	*Diospyros virginiana*	Soursop	*Annona muricata*
persimmon, Japanese	*Diospyros kaki*	Spanish cherry (Brazilian plum)	*Eugenia dombeyi*
Plum; prune	*Prunus domestica*	Spanish cherry; medlar	*Mimusops elengi*
plum, American	*Prunus americana*	Spineless cactus	*Opuntia ficus-indica*
		Sugar palm	*Arenga pinnata*
plum, Golden	*Prunus americana x P. salicina*	Sugar-apple	*Annona squamosa*
		Surinam cherry	*Eugenia uniflora*
plum, Japanese	*Prunus salicina*	Sweet granadilla	*Passiflora ligularis*
plum, Methley	*Prunus salicina* x *P. cerasifera*	Tangelo	*Citrus tangelo*
		Tangerine	*Citrus reticulata*
Poha	*Physalis peruviana*	Tomato	*Lycopersicon esculentum*
Pomegranate	*Punica granatum*	Tree tomato	*Cyphomandra betacea*
Pond-apple	*Annona glabra*	Tropical almond	*Terminalia catappa*
Puapilo	*Capparis sandwichiana*	walnut, Black	*Juglans nigra*
Pummelo; pomelo; shaddock	*Citrus maxima*	walnut, English	*Juglans regia*
Purple granadilla	*Passiflora edulis*	Wampi	*Clausena lansium*
Purple mombin	*Spondias purpurea*	White sapote; sapote cvs.	*Casimiroa edulis*
Quince	*Cydonia oblonga*	Wi apple	*Spondias cytherea*
Red mombin	*Spondias purpurea*	Yellow oleander; Bestill	*Thevetia peruviana*
Rose apple	*Syzygium jambos*		

* Semicolons separate multiple common names. A comma in a common name indicates an inverted name.

† The majority of scientific names have been checked against a database under the National Genetic Resources Program (See References)

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